VOLUME L
NUMBER ONE

THE NATIONAL GEOGRAPHIC MAGAZINE

JULY, 1926

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ARTICLES and photographs are desired. For material which the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage.

IMMEDIATELY after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. Four expeditions have followed and the extraordinary scientific data resulting given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures. As a result of The Society's discoveries this area has been created a National Monument by proclamation of the President of the United States.

AT an expense of over $50,000 The Society sent a notable series of expeditions into Peru to investigate the traces of the Inca race. Their discoveries form a large share of our knowledge of a civilization waning when Pizarro first set foot in Peru.

THE Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole.

NOT long ago The Society granted $25,000, and in addition $75,000 was given by individual members to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people.

THE Society is conducting extensive explorations and excavations in northwestern New Mexico, which was one of the most densely populated areas in North America before Columbus came, a region where prehistoric peoples lived in vast communal dwellings and whose customs, ceremonies, and name have been engulfed in an oblivion.

THE Society also is maintaining expeditions in the unknown area adjacent to the San Juan River in southeastern Utah, and in Yunnan, Kweichow, and Kansu, China—all regions virgin to scientific study.

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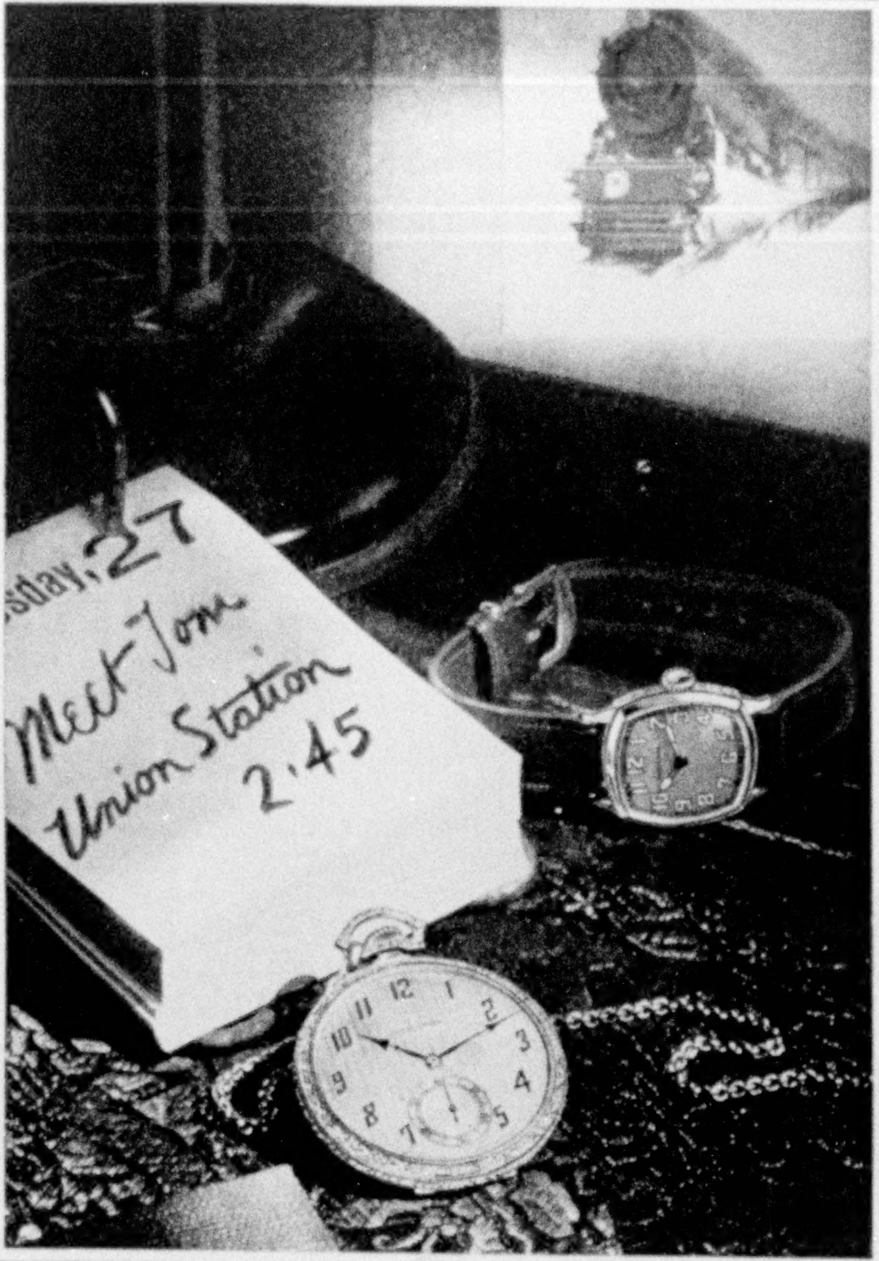

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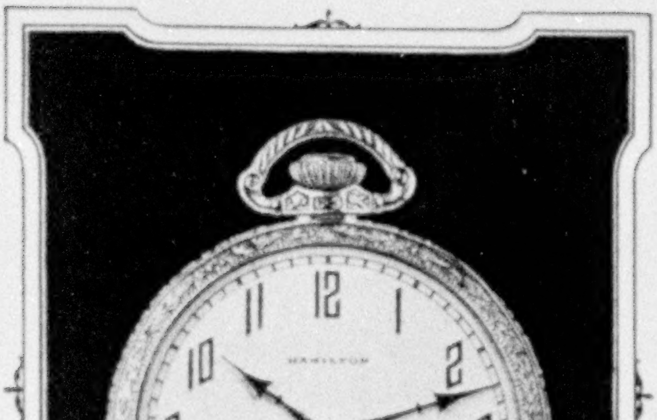

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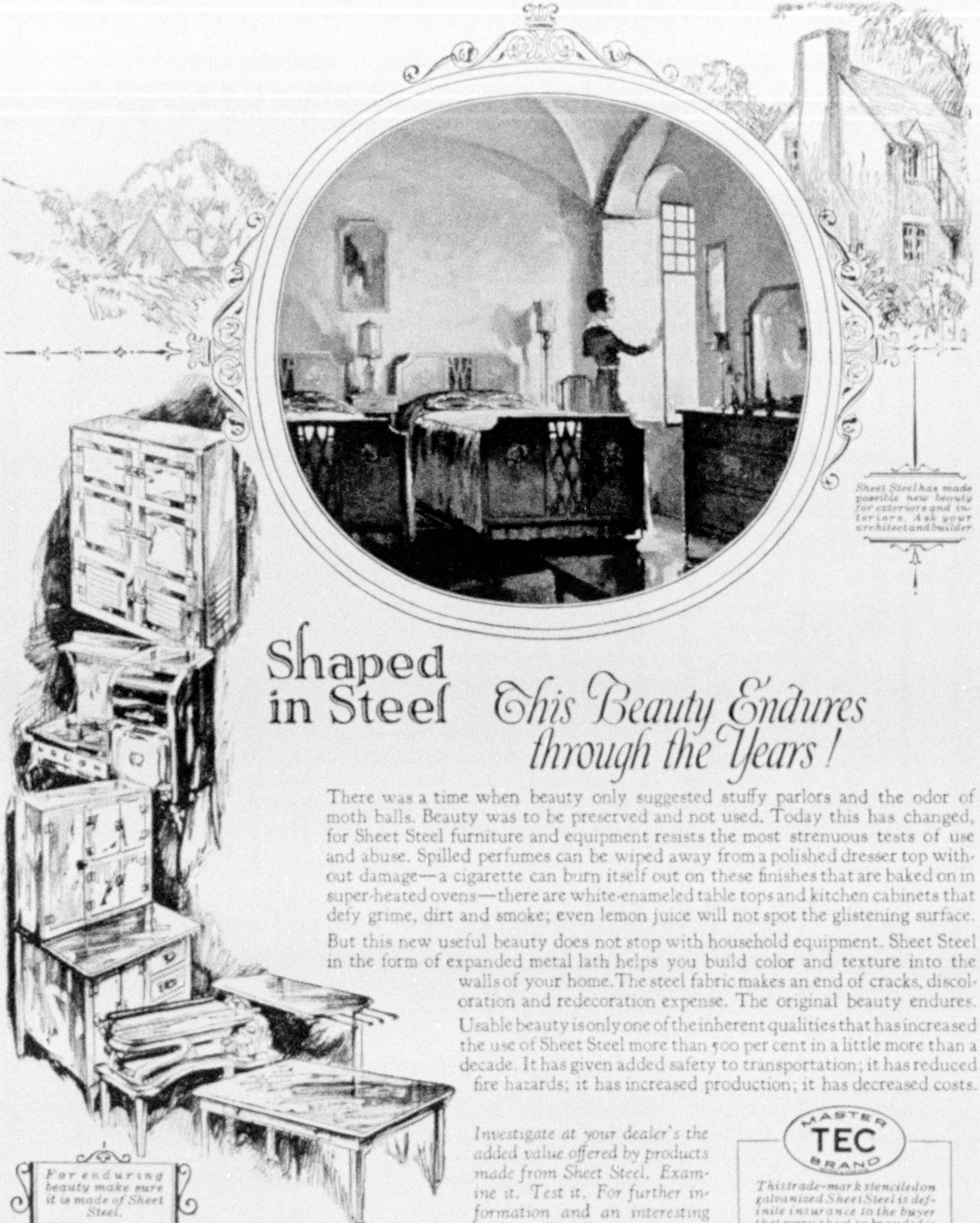

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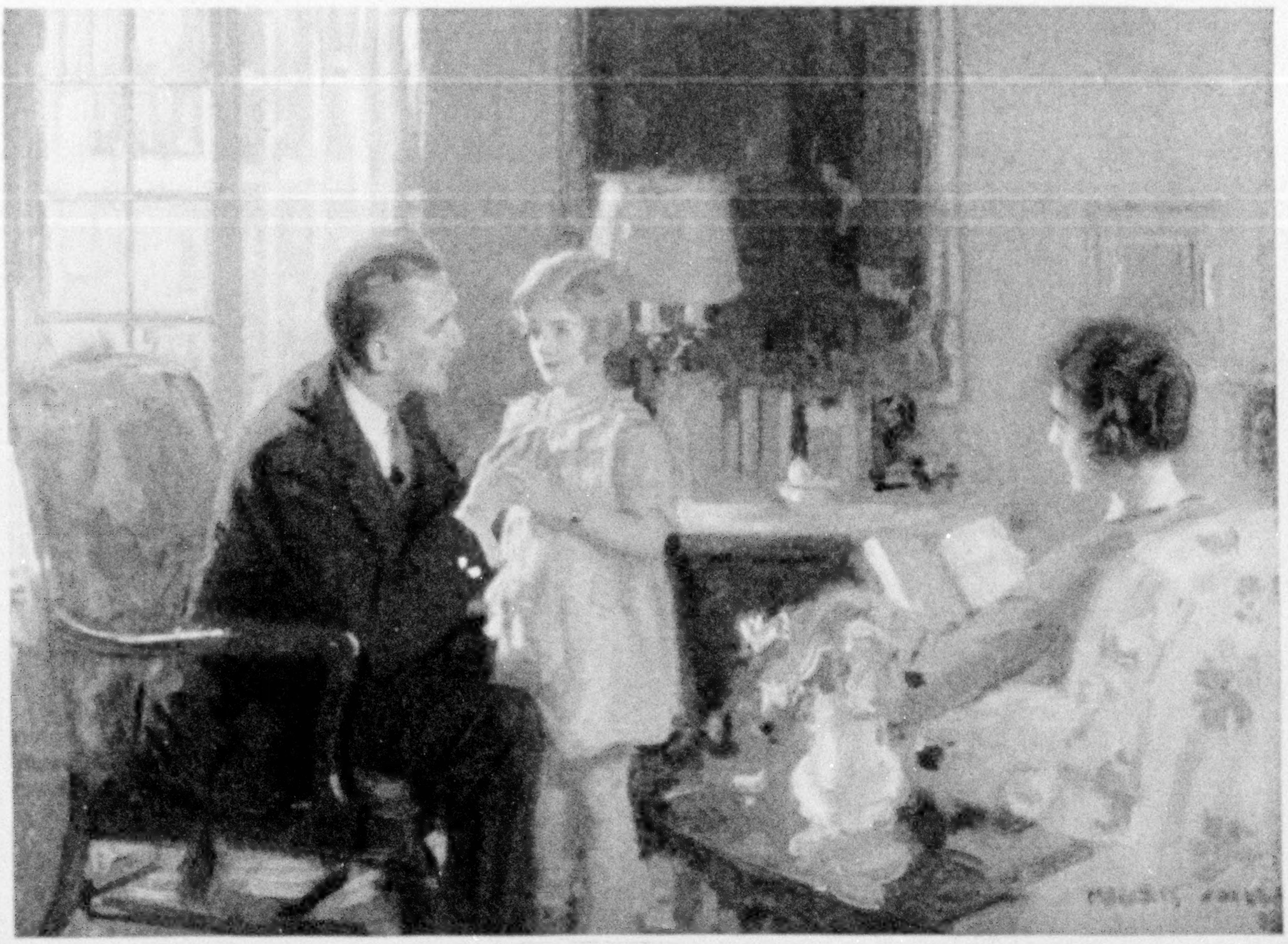

Love's gifts, like love itself, should be everlasting

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* * *

IN choosing a gift, ask yourself two questions: *What should the gift say? . . . And for how long should it continue the saying?*

For a gift is a message from the heart. Its mission is to tell, in beauty and service, what the giver would tell in words.

Choose the gift, therefore, in accordance with the message you would have it carry.

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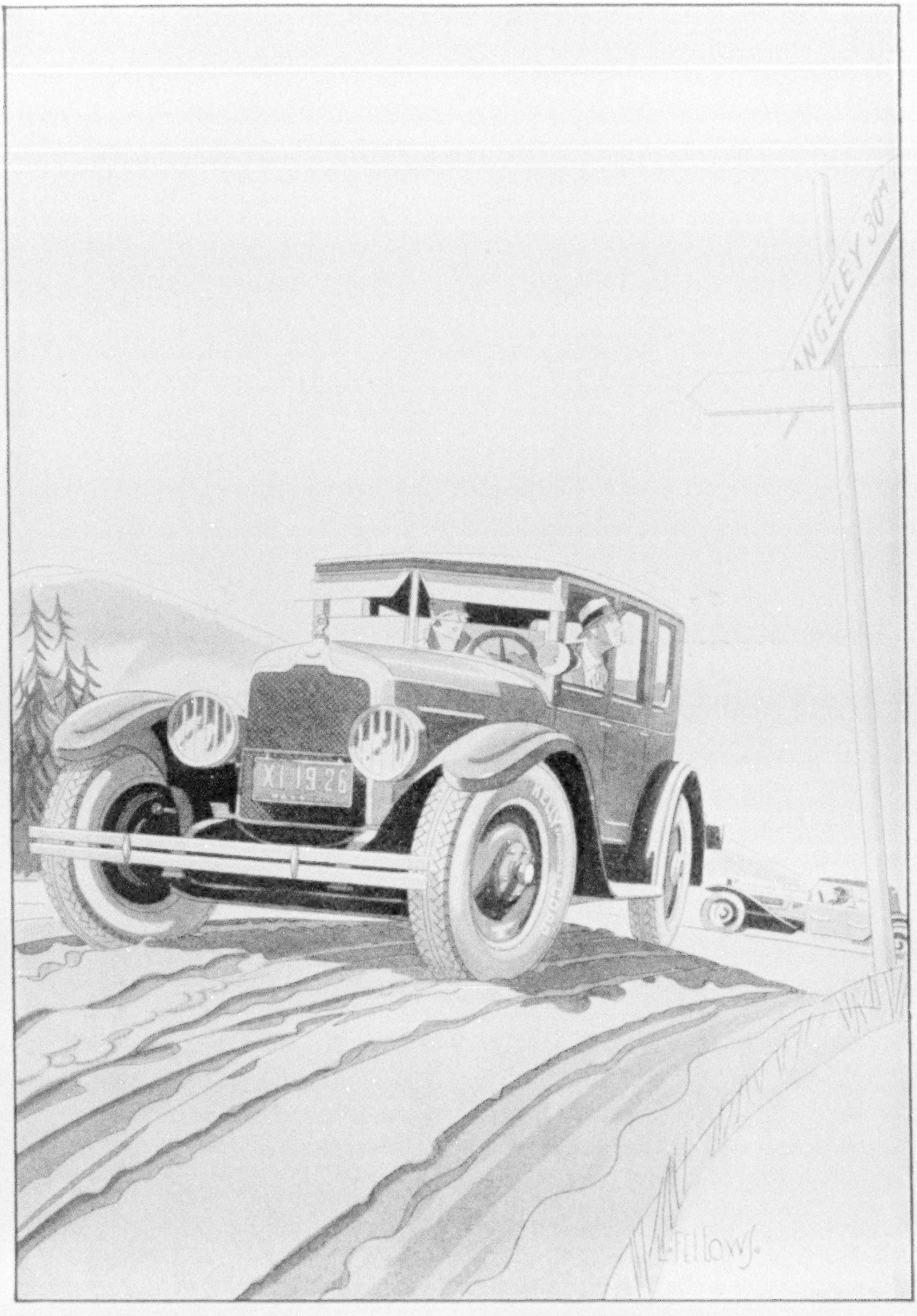
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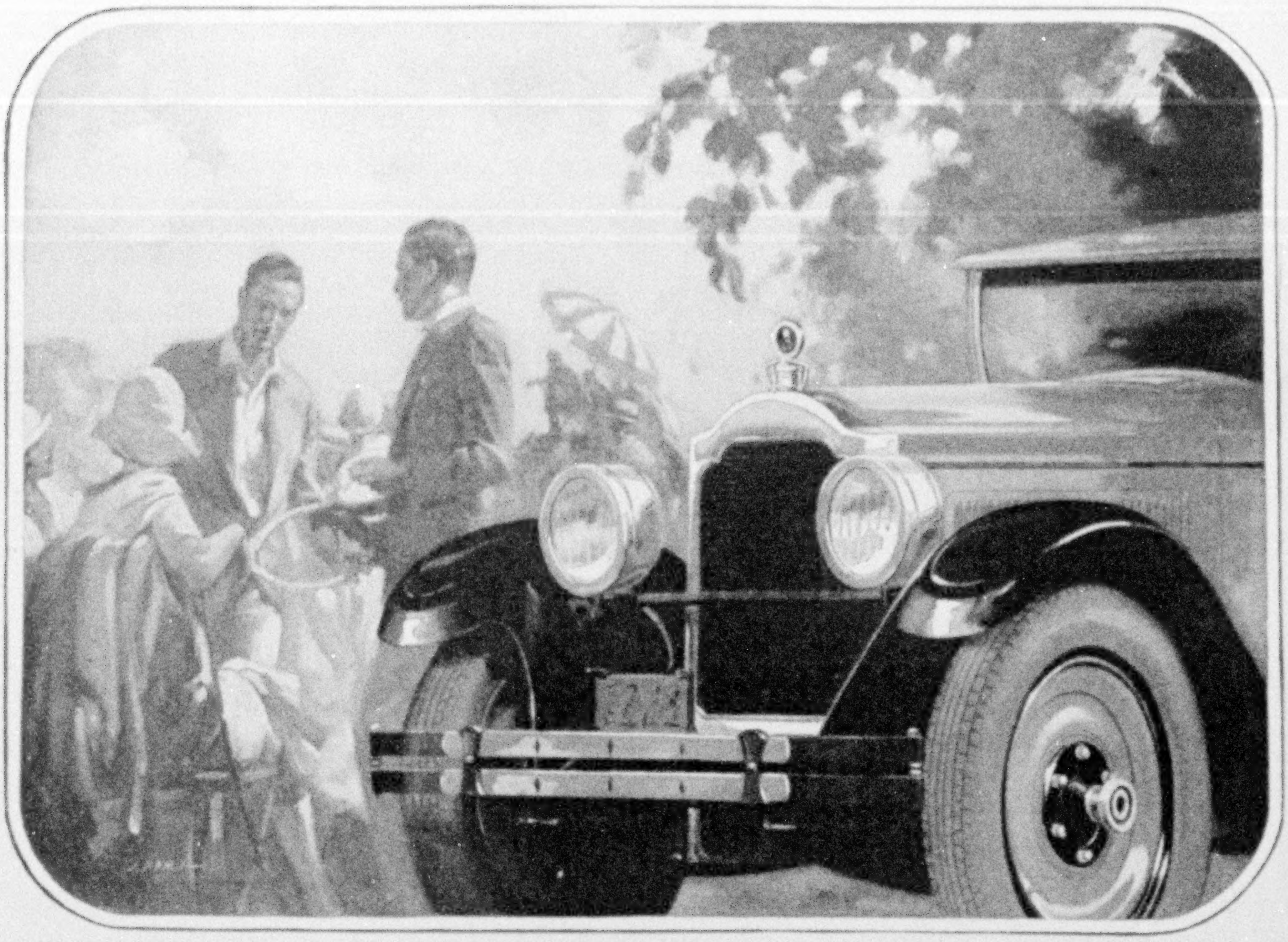

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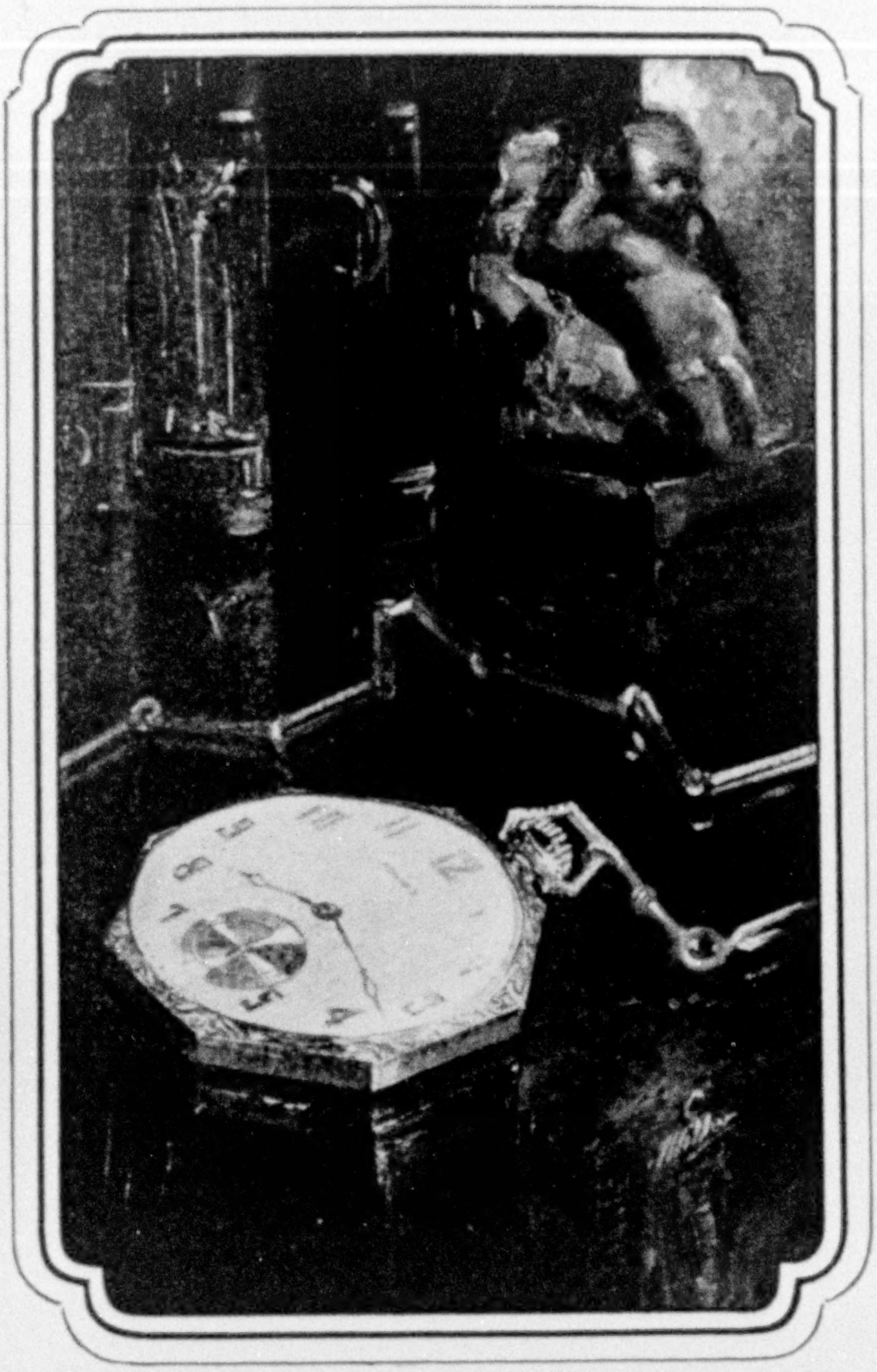

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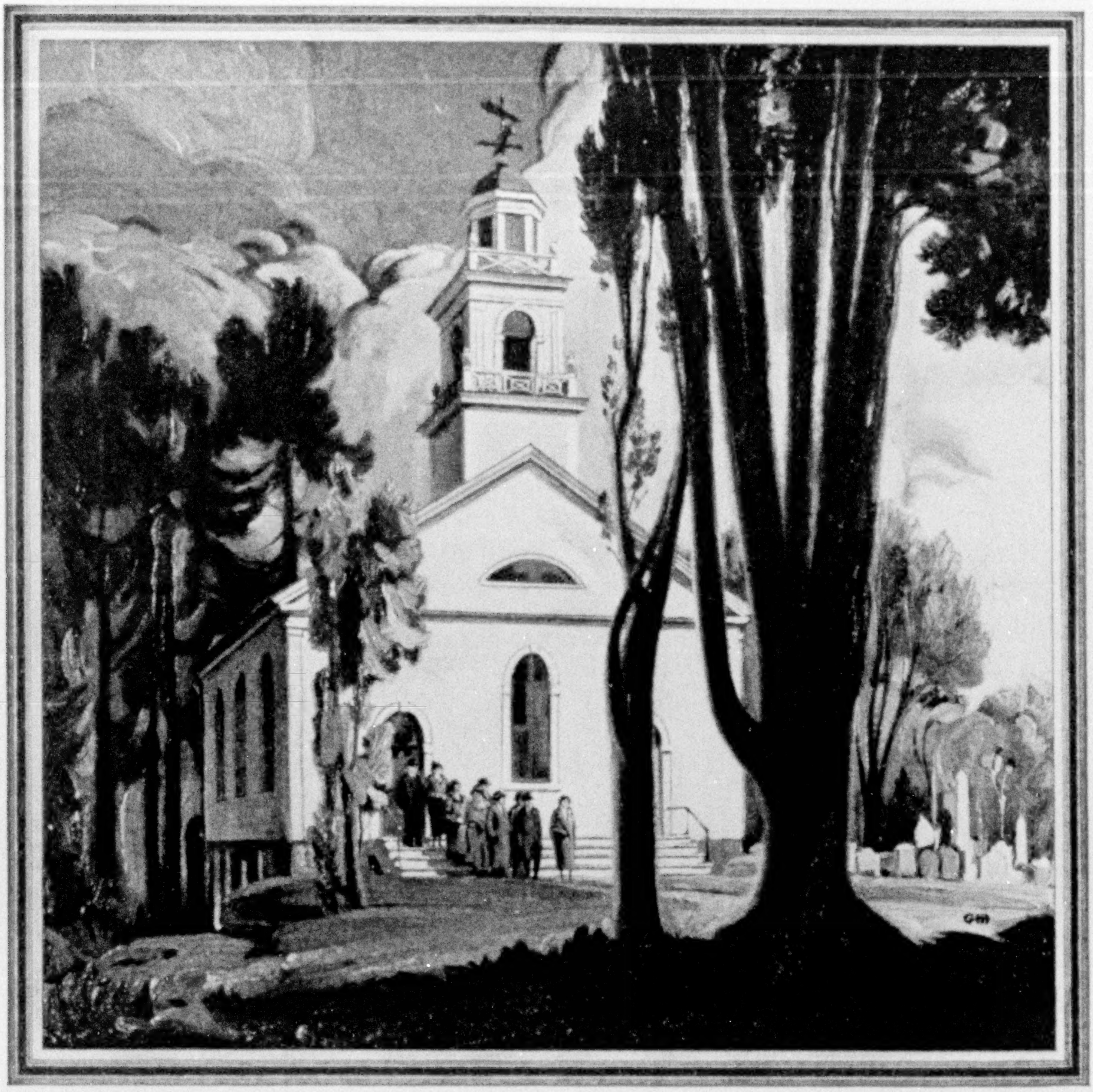

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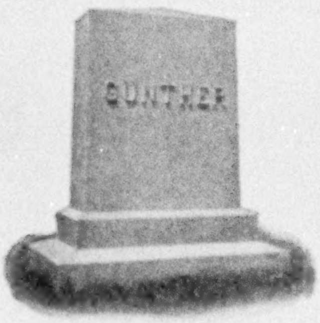

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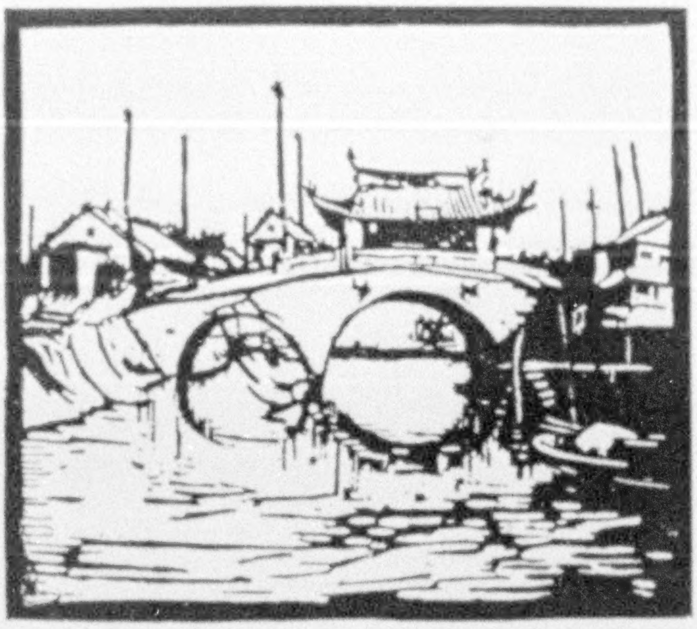

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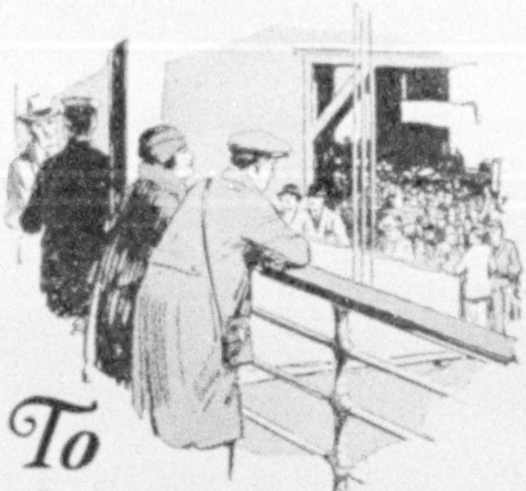

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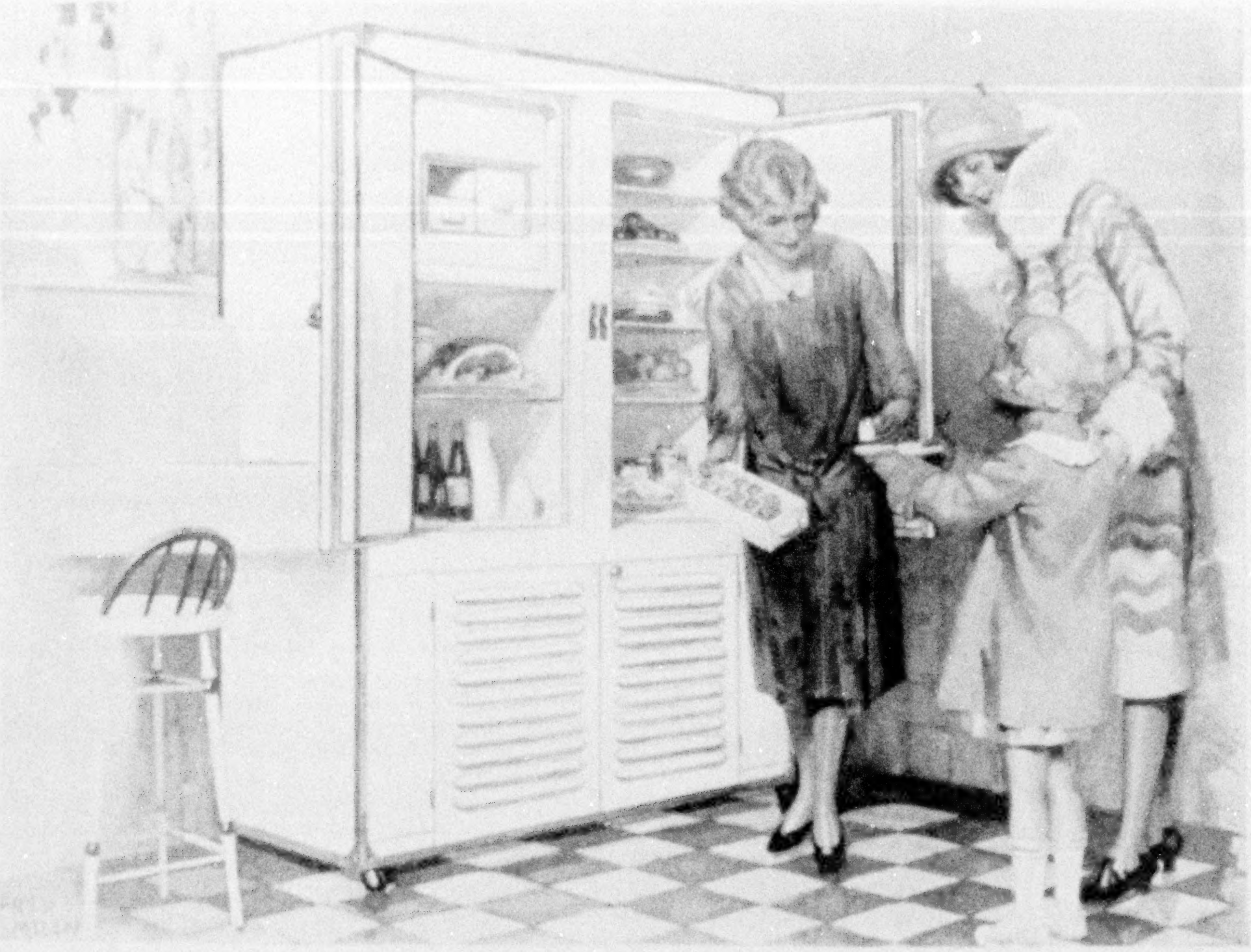

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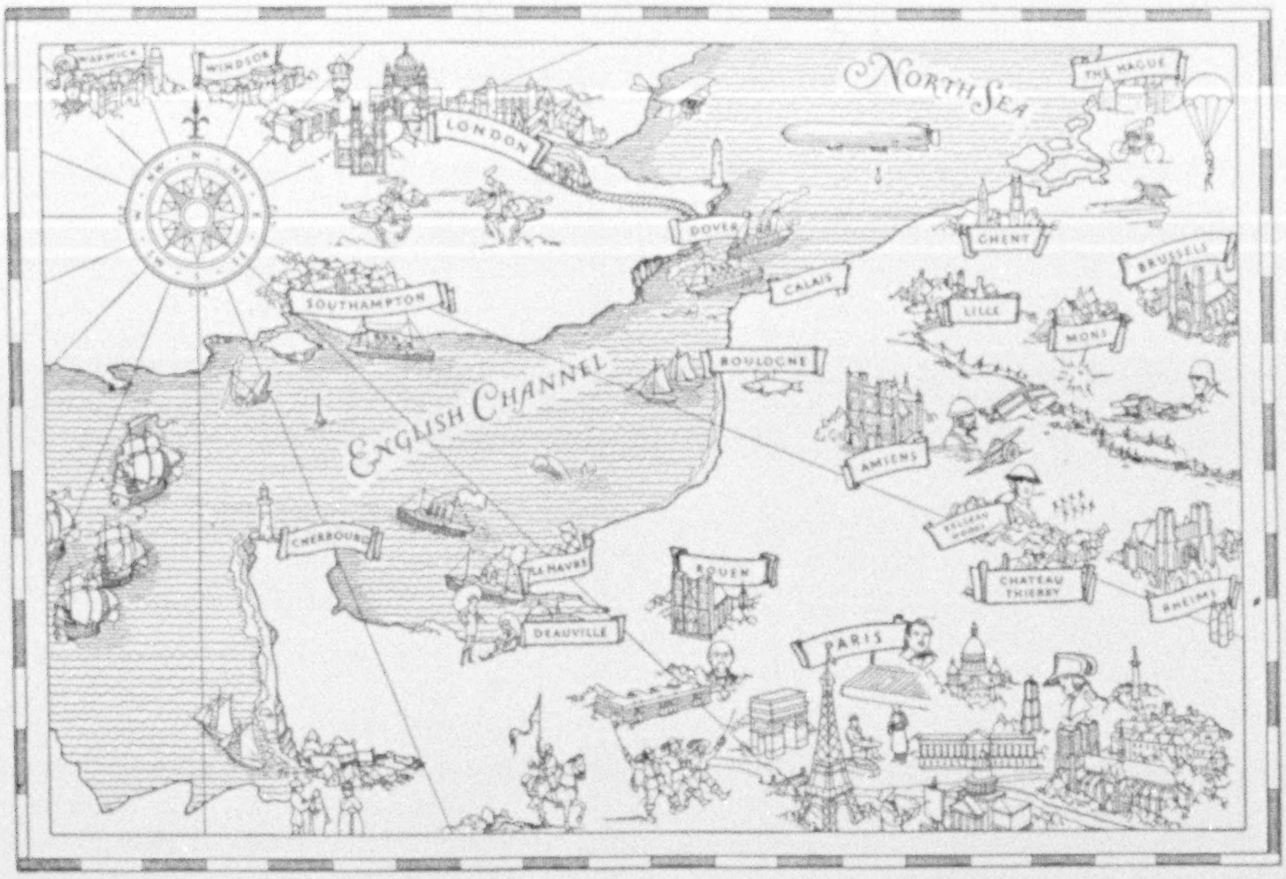

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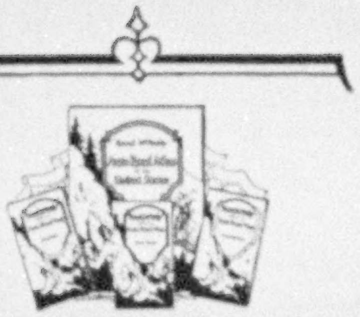

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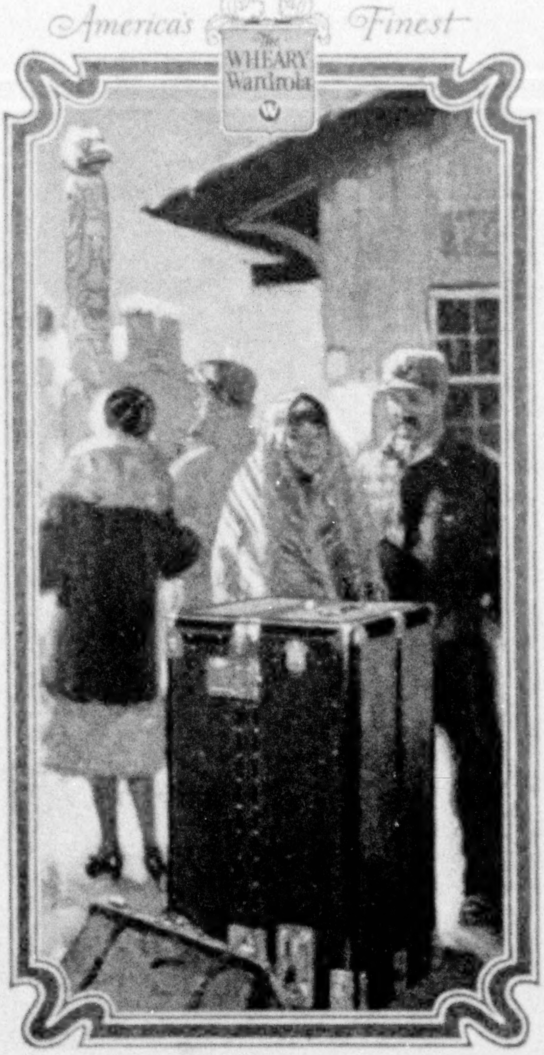

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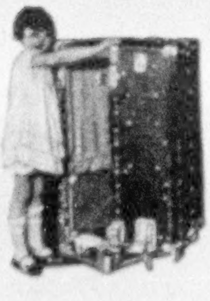

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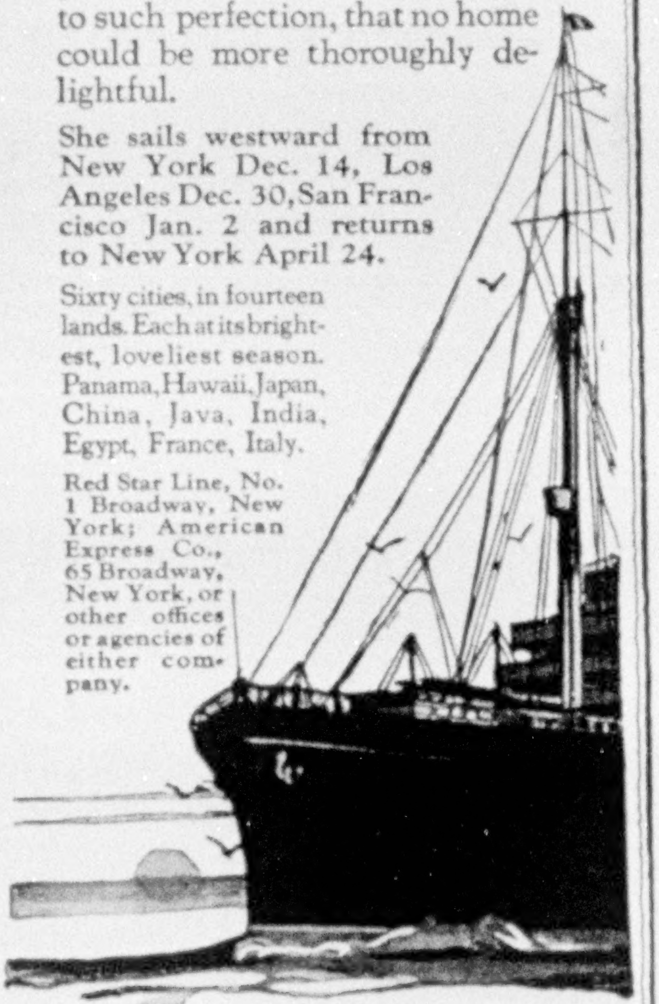

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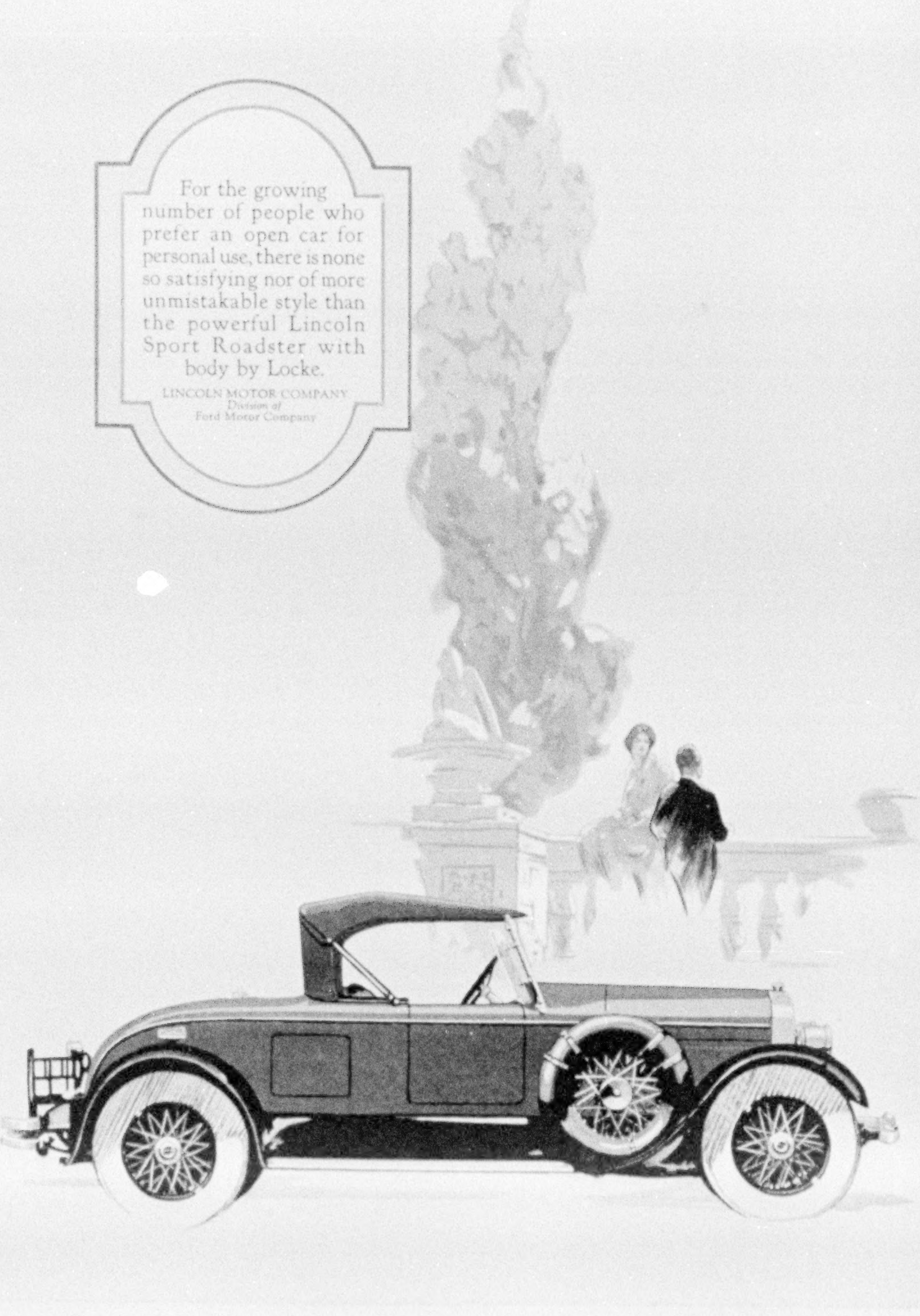

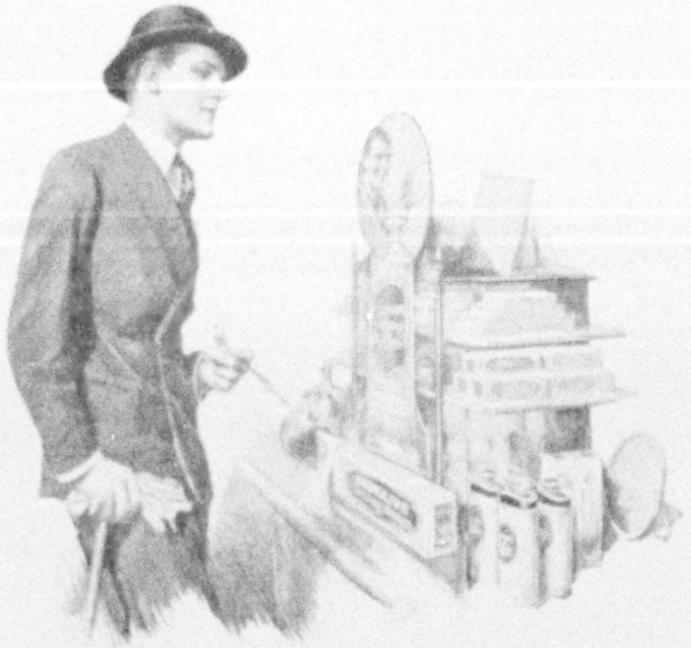

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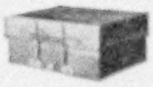

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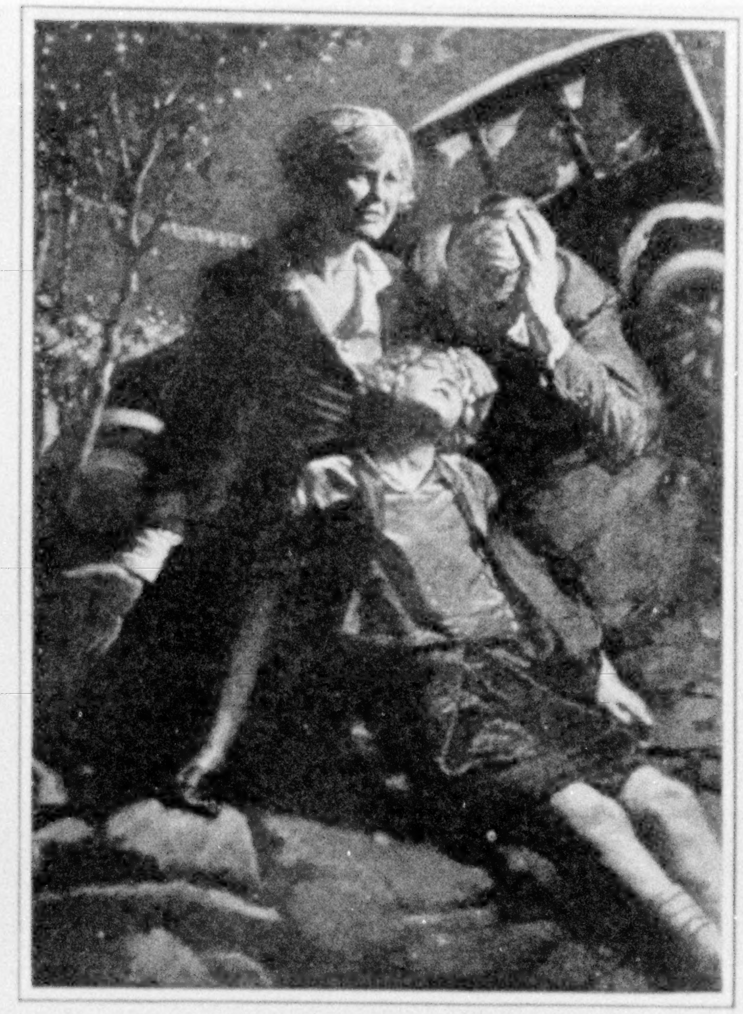

"IN a flash it happened . . . My little girl was hurt. And I could not do a thing to relieve her suffering. There we were—waiting—waiting. The minutes seemed hours. . . . Then along came a car and out jumped a man who began to work, scarcely saying a word. He cleansed her wounds and bound them up with gauze. . . . The doctor said later that he had probably saved her from serious infection. . . . perhaps had saved her life."

PROMPT and intelligent First Aid, deftly rendered, is a life-saving accomplishment when accidents occur—on the road, in the street, in homes or at work. Accidents may happen, any time, wherever you are. Then, of course, you will want to help. But all your sympathy and all your willingness will count for little unless you are prepared to act—quickly.

To prevent infection in minor cuts and wounds—first, apply iodine; second, cover wound with sterilized gauze; third, bind with aseptic gauze bandage; fourth, fasten bandage with adhesive plaster. If a large artery is cut, apply pressure upon it between the wound and the heart with the fingers or a knotted handkerchief. Release pressure every fifteen or twenty minutes so as not to cut off circulation entirely for too long a time.

—These are the things you can do before the doctor comes. Just a few First Aid materials are needed—but when they are needed, they are needed instantly. Seconds are precious!

Although automobile manufacturers are building sturdier cars than ever before, staunchly equipped with brakes and strong steering apparatus, the number of automobile accidents has steadily increased from year to year. In 1925 there were ten times as many deaths from this cause as there were in 1911.

Last year, more than 600,000 persons were seriously injured and 21,000 lost their lives. Because motor cars are easily handled, careless persons forget the tremendous power of these swift-moving vehicles.

A knowledge of what to do and a First Aid emergency equipment are invaluable—not only in the car but at home where injuries frequently occur from cuts, falls, burns, scalds or poisons. The Metropolitan Life Insurance Company will gladly mail you, without cost, a booklet on First Aid which tells the things you should know to be able to save lives.

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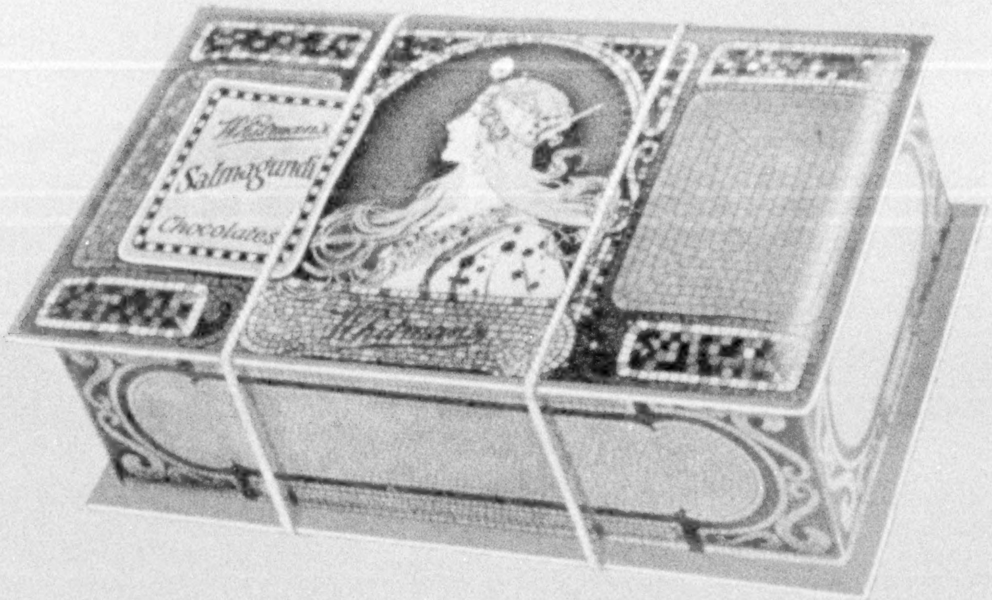

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Wherever folks gather in the care-free, informal, outdoor summer life, where talk is light-hearted and laughter is spontaneous—there you will find Whitman's Chocolates in circulation.

Oh, the zest of good chocolates after exercise!

Whitman's Salmagundi package fits perfectly into the picture of a perfect summer day. It remains in the memory as a real addition to the delights of vacation days.

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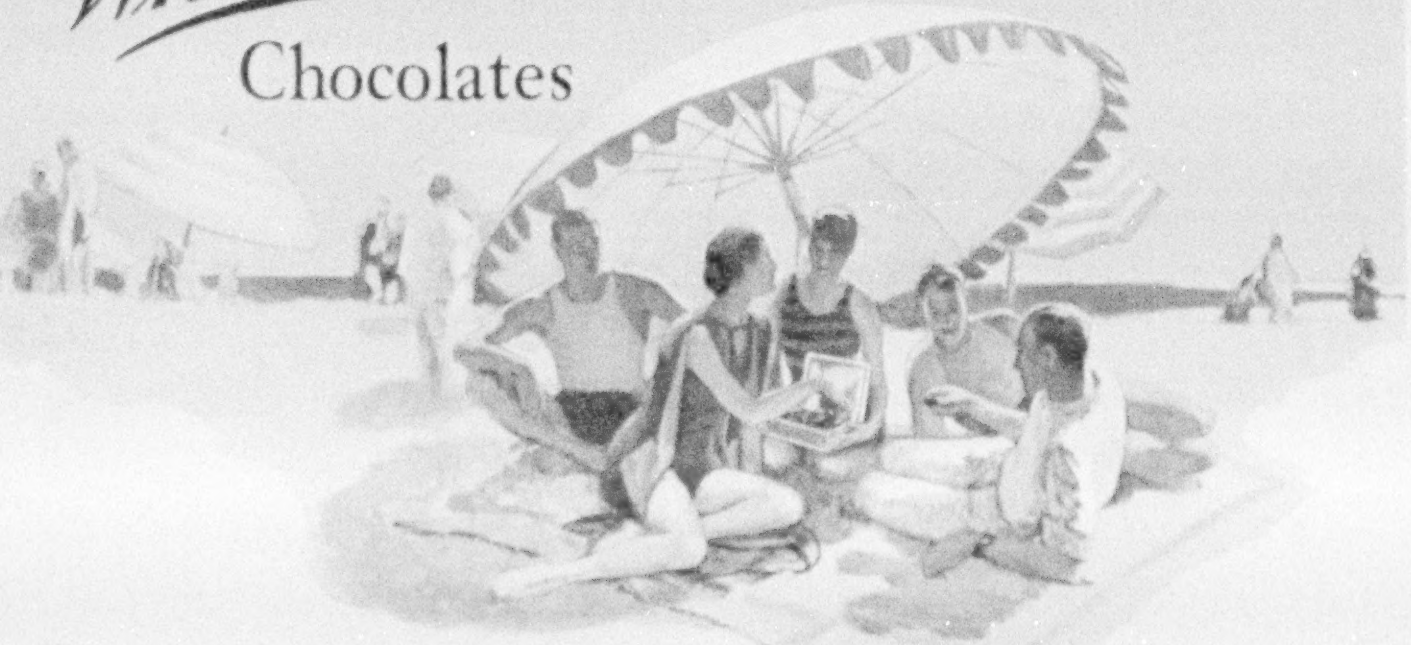

Vol. L, No. 1 WASHINGTON July, 1926

THE NATIONAL GEOGRAPHIC MAGAZINE

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STANDING ICEBERG GUARD IN THE NORTH ATLANTIC

International Patrol Safeguards the Lives of Thousands of Travelers and Protects Transatlantic Liners from a "Titanic" Fate

By Lieutenant Commander F. A. Zeusler, U. S. Coast Guard

IN the North Atlantic Ocean is one of the dreariest areas on the globe. It is usually at the mercy of the sweeping gales or in the grip of the densest fogs.

This area, the southeastern edge of the Grand Banks of Newfoundland, is where the cold Labrador Current from the Arctic breasts the greater might and greater volume of the warm Gulf Stream.

Over this scene of conflict, like a smoke pall over a battlefield, lies a blanket of fog, present 40 per cent of the time in winter and fully half the time in summer.

But through this dreary region men have projected the busiest water trade route in the world (see map, page 4) and on the Banks is located one of the most famous of fishing grounds.

Here the captains of passenger liner and fishing vessel, alike, dare the dangers of an ugly-mooded ocean.

Until a few years ago these shipmasters of the North Atlantic had also the added fear in their hearts that across their bows might loom unexpectedly the dark and ominous blur of a gigantic iceberg shrouded in snow, fog, or gale. Sometimes only a brief hundred yards may separate ship and berg before it is possible to discern the specter.

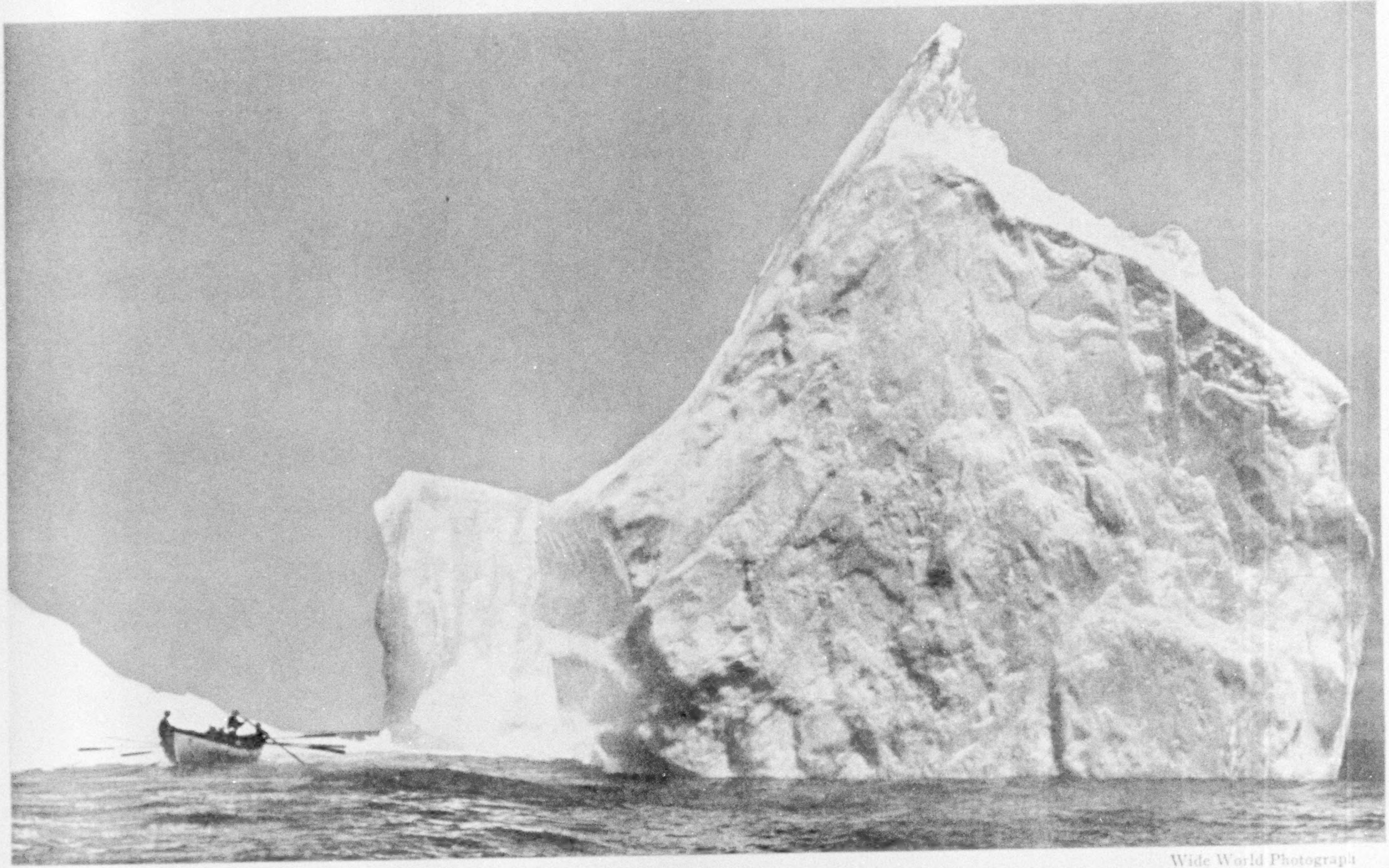
It was in this area of peril that the greatest disaster ever recorded in the history of ocean travel occurred—the sinking of the *Titanic* on the night of April 14-15, 1912, after collision with an iceberg, with a loss of more than 1,500 souls.

THE "TITANIC" DISASTER BROUGHT ABOUT THE ICE PATROL

The *Titanic* catastrophe shocked the entire world, and a universal demand arose for a patrol of the ice area. Immediately the United States Navy detailed two cruisers for guard duty until the last bergs disappeared from the steamer lanes in late June. In the spring of 1913 no Navy vessels were available, so two Revenue cutters were detailed to carry out the patrol.

During the fall of the same year the International Conference for the Safety of Life at Sea was convened at London, to organize this patrol on an international basis, in recognition of its service to ships of all nations. Representatives of the principal maritime nations of the world signed the agreement on January 20, 1914, creating the International Derelict Destruction, Ice Observation, and Ice Patrol Service.

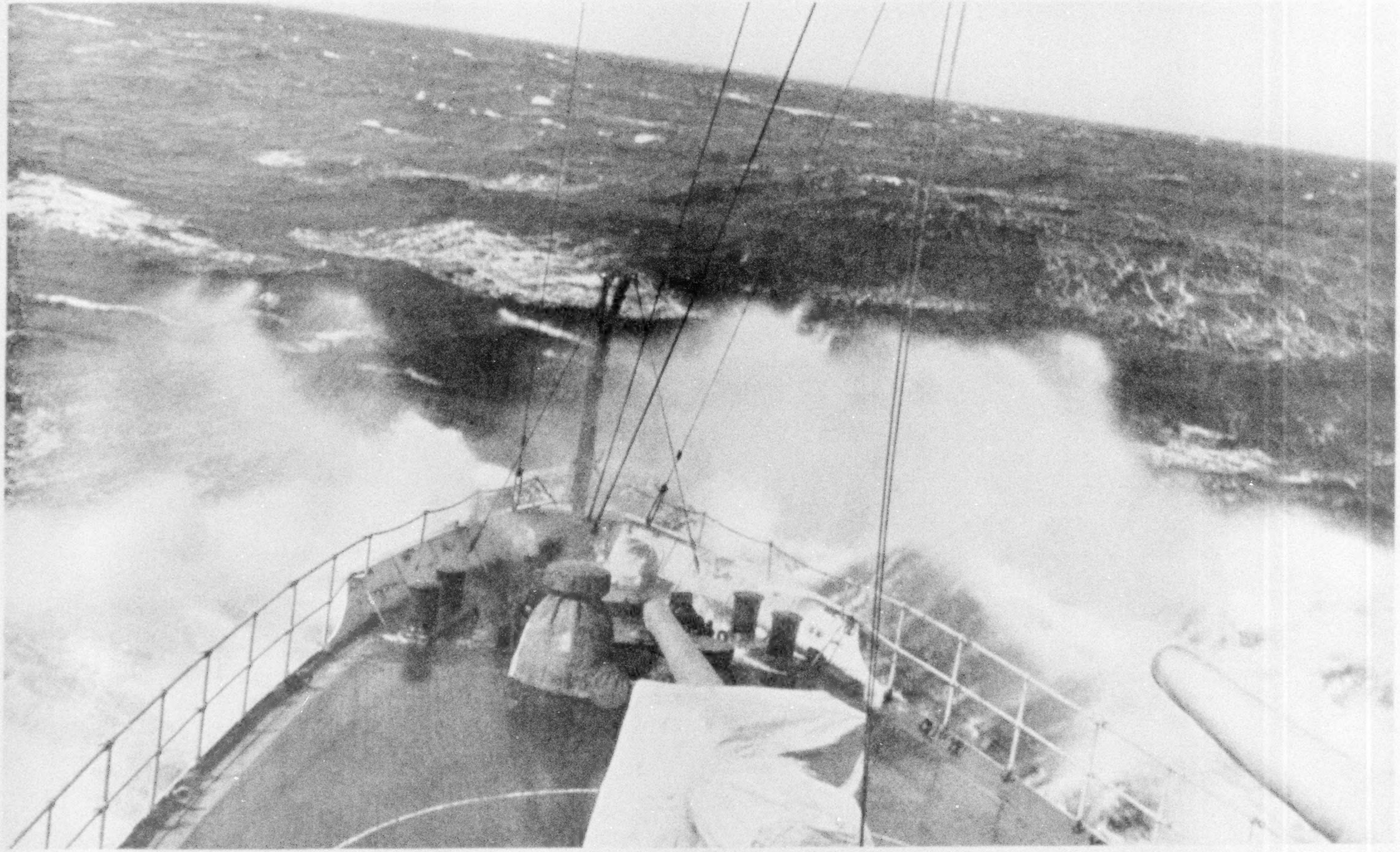
The United States was asked to undertake the management of this service. This country agreed to send two vessels which would patrol the danger area during the



Wide World Photograph

THE WHITE TERROR OF THE ATLANTIC SHIP LANES

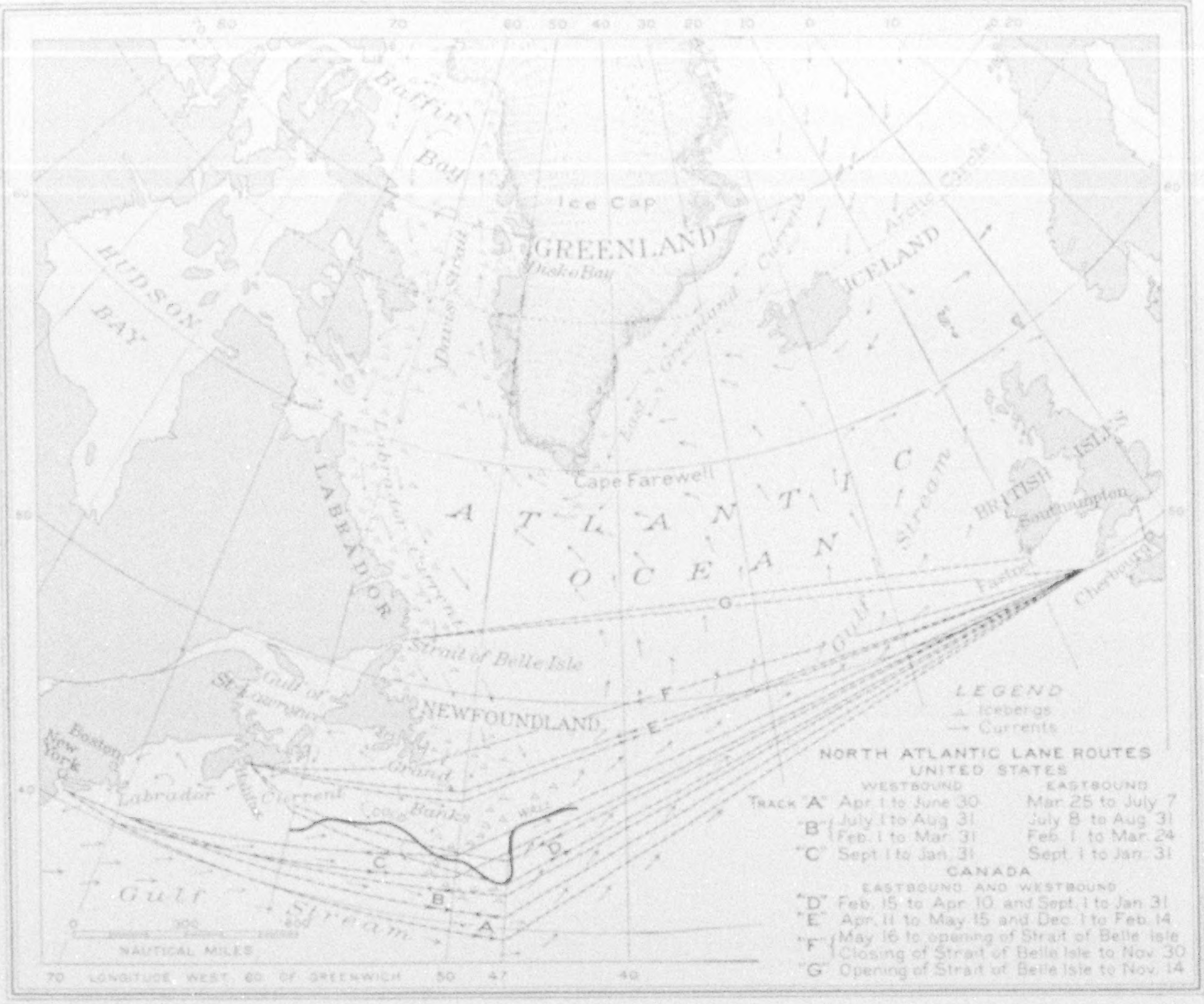
A huge iceberg sighted in the North Atlantic by the Coast Guard cutter *Tampa* within a few days of the thirteenth anniversary of the sinking of the *Titanic*.



Photograph by N. Brunilla

AN ICE PATROL CUTTER IN HEAVY WEATHER AT SEA

The *Tampa* and the *Modoc* divide the responsibility of keeping a constant vigil in the North Atlantic in order to warn transatlantic liners of the iceberg menace. One or the other of these sturdy vessels is on guard night and day, in fair weather and foul, for four critical months.


Baffin Bay
Ice Cap
GREENLAND
Disko Bay
Davis Strait
HUDSON BAY
ICELAND
East Greenland Current
Arctic Circle
Cape Farewell
LABRADOR
Labrador Current
ATLANTIC OCEAN
BRITISH ISLES
Southampton
Fastnet
Cherbourg
Gulf Stream
Strait of Belle Isle
Gulf of St Lawrence
NEWFOUNDLAND
Grand Banks
Boston
New York
Sable Island
COLD WALL
NAUTICAL MILES
LONGITUDE WEST 60 OF GREENWICH
LEGEND
Icebergs
Currents
NORTH ATLANTIC LANE ROUTES
UNITED STATES
WESTBOUND
EASTBOUND
Track "A" Apr 1 to June 30 Mar 25 to July 7
"B" July 1 to Aug 31 July 8 to Aug 31
Feb 1 to Mar 31 Feb 1 to Mar 24
"C" Sept 1 to Jan 31 Sept 1 to Jan 31
CANADA
EASTBOUND AND WESTBOUND
"D" Feb 15 to Apr 10 and Sept 1 to Jan 31
"E" Apr 11 to May 15 and Dec 1 to Feb 14
"F" May 16 to opening of Strait of Belle Isle
Closing of Strait of Belle Isle to Nov 30
"G" Opening of Strait of Belle Isle to Nov 14

Drawn by A. H. Bumstead

THE ICEBERG DANGER ZONE IN THE NORTH ATLANTIC

From March 1 to July 1 this dreary space of fog-bound ocean is patrolled by two vessels of the United States Coast Guard, with a third vessel in reserve. One of the three is on guard 24 hours a day to protect ships plying the busiest water trade route in the world.

iceberg season. Each of the contracting parties consented to bear a share of the cost in proportion to its shipping tonnage.

The United States Revenue Cutter Service, now known as the United States Coast Guard, was charged with the duty of maintaining the patrol.

Therefore, when the cutters sail for the Banks' ice guard every March, they go in the name of Belgium, Canada, Denmark, France, Germany, Great Britain, Italy, Netherlands, Norway, Sweden, and the United States, but serve the shipping interests of the entire world.

Icebergs have always been the dread of the transatlantic navigator. They drift hither and yon. They give no warning of their presence. They are propelled now by ocean currents, now by tides, and now by winds and waves. Fog is their constant companion.

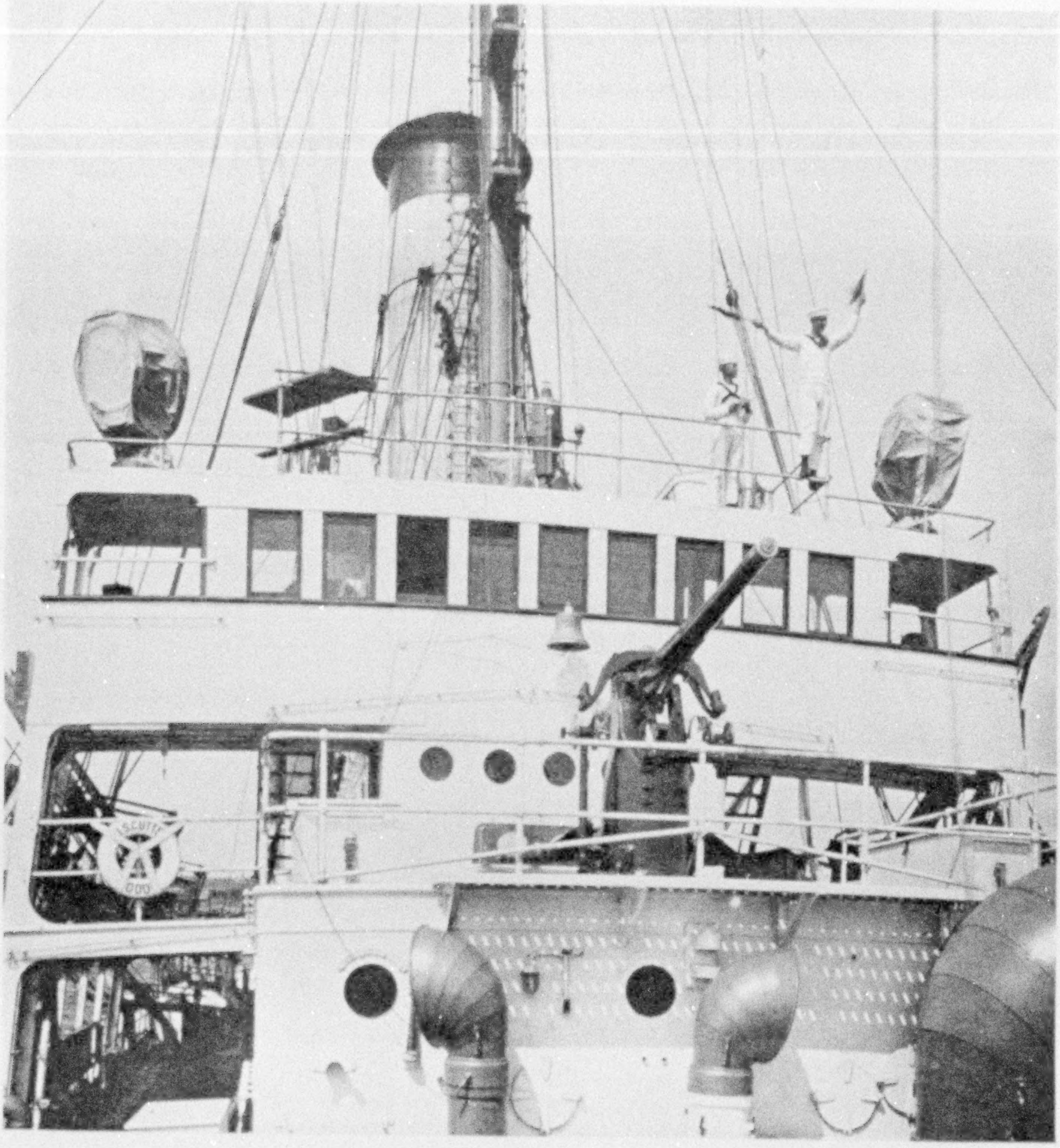
A vessel speeding through an area infested with moving ice, during night or in fog, plays a game of chance. Even on a starlit night a berg cannot be seen beyond a half mile; but when the position of the ice is known to the navigator, the danger is eliminated; he can alter his course to avoid the menace.

NO SHIP SACRIFICED TO ICEBERGS IN 14 YEARS

The ice comes down every year, as it has for centuries; but now every berg that follows the eastern edge of the Grand Banks into the steamer lanes is kept under surveillance by the International Ice Patrol. From this Service navigators can learn the answer to the question which each asks: Where is the ice?

Not a single ship has been lost through collision with an iceberg since the patrol was inaugurated, fourteen years ago.

Greenland's "icy mountains" alone are



Photograph from Lieut. Commander F. A. Zeusler

READY TO STAND WATCH ALONG THE LANES OF TRAVEL IN THE NORTH ATLANTIC

The *Modoc* and the *Tampa* comprise an international fleet, for while these Coast Guard ships fly the United States flag and are manned by American officers and seamen, the patrol is maintained in the names of Belgium, Canada, Denmark, France, Germany, Great Britain, Italy, Netherlands, Norway, Sweden, and the United States (see text, page 4).

the source of the icebergs that come as far south as the steamer lanes, journeying about 1,800 miles—approximately the distance from Washington, D. C., to Denver—before they become "white specters" to shipping.

With the exception of a small strip of coast line, Greenland is completely covered with a vast ice cap.* Its estimated thickness is 5,000 feet.

Always the ice mantle is moving down the slope of the land toward the sea, in great glaciers, pushing out through the valleys. As the ice reaches the sea it noses out into the water until buoyancy lifts it up, and then the front of the glacier breaks off at a weak spot.

There is a deafening roar and a thunderous crash, and with a tidal splash the glacial fragment plunges heavily into the sea, almost submerging. The water is

---

* See "Flying Over the Arctic," by Lieutenant Commander Richard E. Byrd, in the NATIONAL GEOGRAPHIC MAGAZINE for November, 1925.

Photograph by Lieutenant N. G. Ricketts

RECEIVING A MESSAGE IN THE "MODOC'S" RADIO ROOM

This operator transfers from ship to ship at sea with the ice observer and does not see land from March to July (see text, page 7).

churned into creamy waves as the newborn berg shakes off the sea, regains its equilibrium, and settles itself comfortably for a long journey southward.

It rides majestically, indifferent to the fact that it has set sail for oblivion.

GREENLAND GLACIERS ARE SOURCES OF ICEBERGS

There are eight principal berg-producing glaciers in Greenland. The worst offenders are those of Disko Bay, Jakobshavn, and Torsukatak, Karajak, and Umanak. Then there are the three other west coast glaciers—Upernivik, Godthaab, and Frederikshaab.

One berg-producer, the Sermilik Glacier, is on the east coast; but it is of no moment, as far as the steamship captain is concerned, since bergs from this coast rarely ever menace the travel lanes.

Bergs are discharged in vast numbers from these Greenland fiords. Yet few come south of Newfoundland. Many are too small to last long. Many ground on the shores of Labrador and Newfoundland, particularly in years when the shore ice is scant. Others are caught in an eddy of the Gulf Stream off the southern tip of Greenland and melt away.

Only the fittest survive the buffetings of the sea, to be carried south on the flow of the Labrador Current and along the eastern edge of the Banks into the Gulf Stream. This warm current gives them short shrift; but until they have dwindled to the size of an ample library desk they are capable of staving in a vessel's plates.

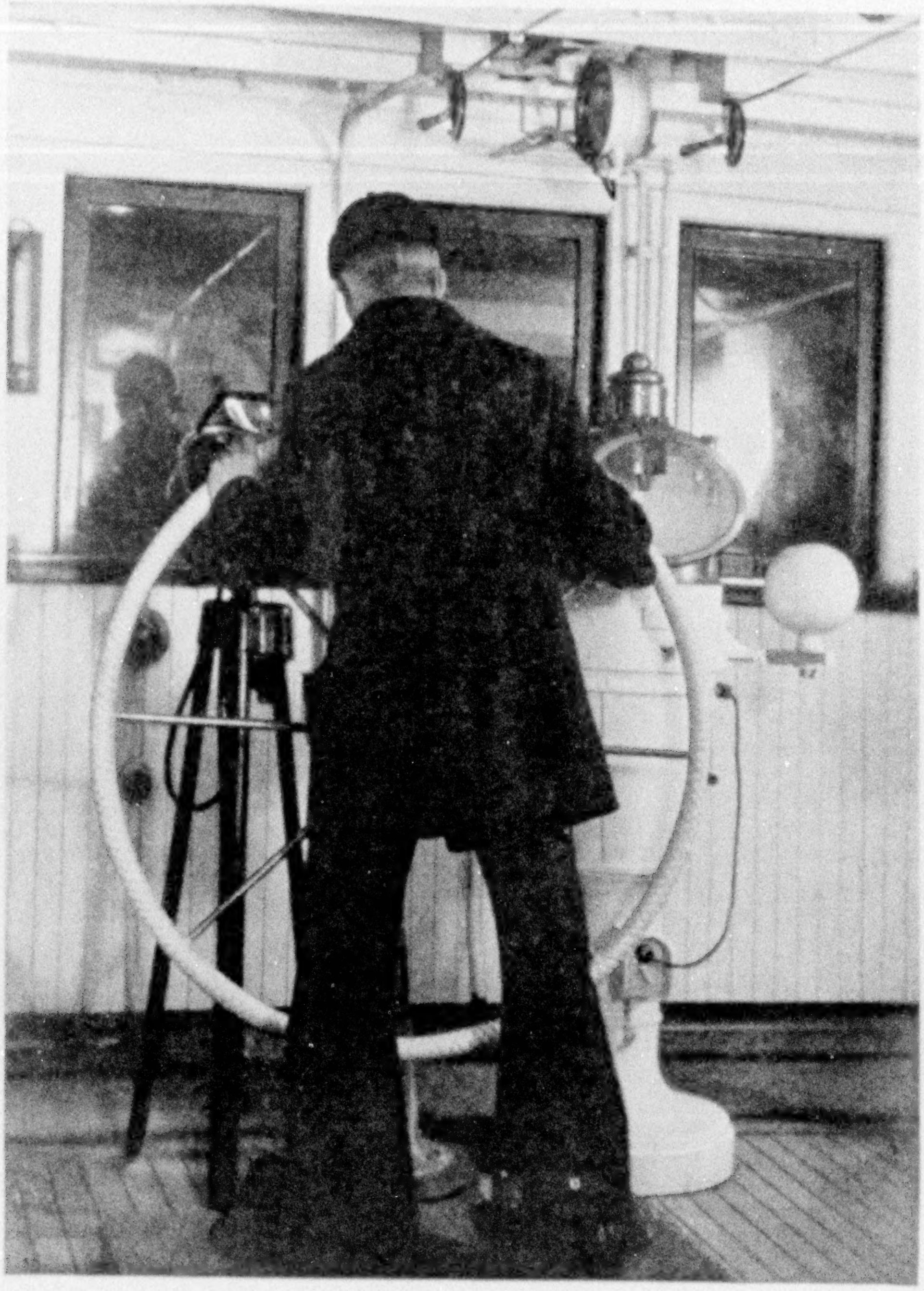
The Labrador Current, although a danger-carrier, has its usefulness. It teems with all kinds of marine life, affording breeding and feeding grounds for our best food fish.

The current from the Arctic does not have a year-round constant flow along the Grand Banks. Like a river, though for different reasons, it is in flood in the spring. Beginning in February, it picks up volume and speed, reaching a maximum toward the last of April, when it is a real power, gathering sufficient force to whirl the bergs along at a rate of more than two miles per hour. Then the Gulf Stream gradually spreads north and pinches it off.

The berg danger period coincides with the heavy flow period of the Labrador Current each year—that is, from March 1 to July 1. It is during this period that the cutters patrol the ice-endangered areas.

THREE CUTTERS ASSIGNED TO ICE PATROL

Two cutters, the *Tampa* and the *Modoc*, are assigned to the Ice Patrol, with a third cutter, the *Seneca*, held in reserve. For the season of 1925 I was appointed oceanographer with the service, and since the *Tampa* was to be the first on the Banks, I joined her in the Boston Navy Yard early in February.


Photograph by Lieutenant N. G. Ricketts

"ON THE BRIDGE AT MIDNIGHT"

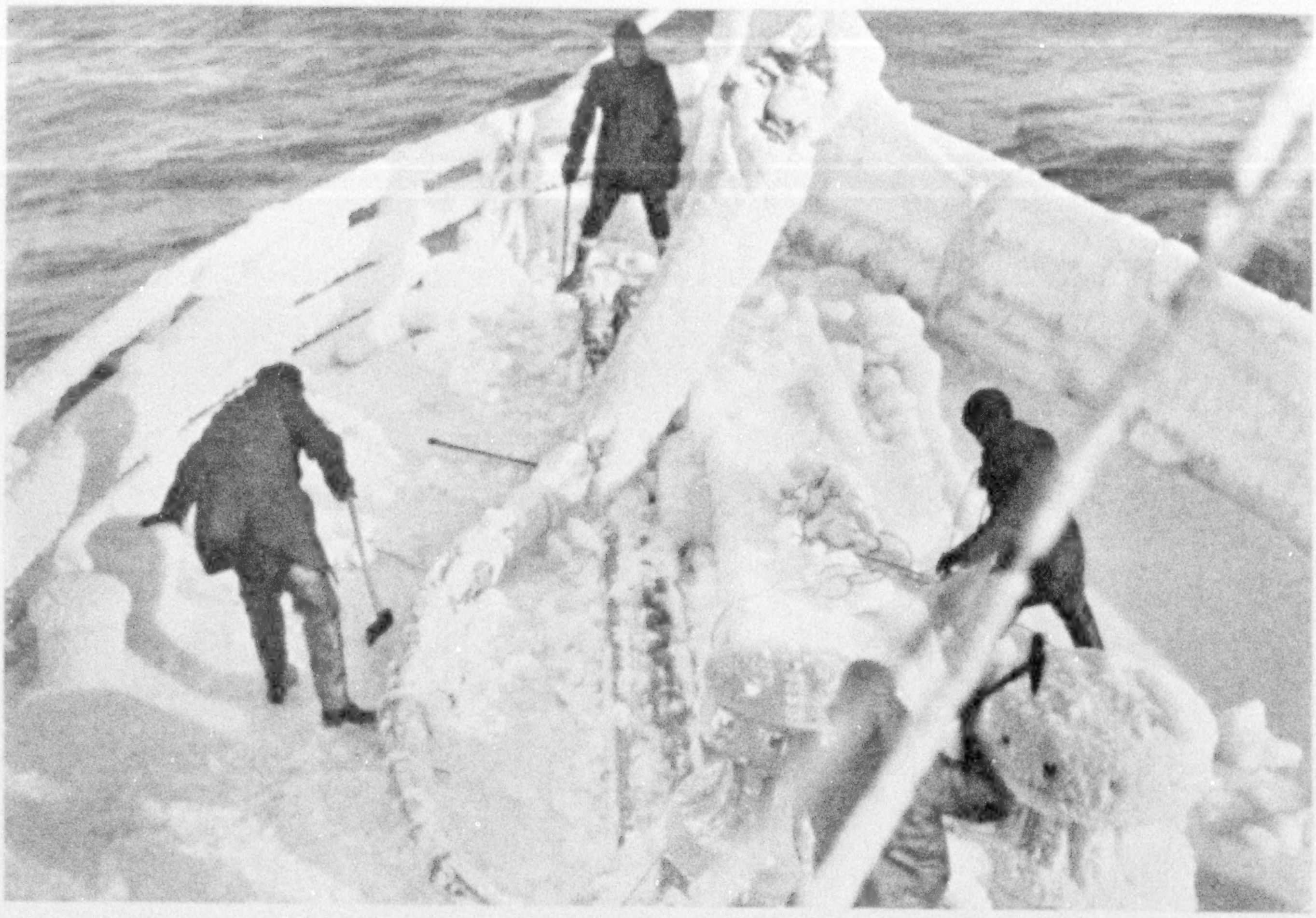
One of the special duties for the 1925 season was to experiment with a sonic depth-finder, so I spent five weeks in making preparations for that duty. This reconditioning and fitting-out activity carried us far past March 1, the usual opening of the season; but it was safe, because the previous year had been a little ice year and the winter had been very mild, so we knew no early ice threatened the lanes.

It was my duty to be on the Banks from the beginning to the end of the season. Every two weeks one cutter relieved the other; but when the *Tampa* went to Halifax, the refueling and revictualing base, my two aides and I transferred to the *Modoc;* and when the *Modoc* in turn headed for shore leave, we three bade it good-bye, 450 miles off the coast of Massachusetts, and boarded the *Tampa*.

The oceanographer is the navigating officer. He must know his vessel's position any moment of the day or night. He is the Ice Patrol aide to the commanding officers of the vessels and keeps a changing record of the movements of all the ships within 400 miles.

Since the patrol vessel lies in the main steamer lane of the world, this is much like counting a big flock of sheep jumping over a fence. He keeps tab on all ice floating into the steamer lanes and sends radio warnings of weather, derelicts and ice, prepares weather charts, receives and answers requests from ships by radio, and is responsible for all experiments.

Two experiments carried out last season were of unusual interest. Both were undertaken in connection with the constant search by the Ice Patrol Board for some method either of banishing the ice-



Photograph by Lieut. Commander F. A. Zeusler

HEWING THE "MODOC'S" DECKS FREE OF ICE

Cold weather is encountered while on patrol searching for the first ice of the season, above latitude 48° north.

berg from the North Atlantic or increasing the factor of safety.

We attempted to apply the sonic depth-finder to the problem of locating icebergs, and while our tests produced only fair results, they paved the way for detection experiments with radio waves in place of sound waves, which will be undertaken when the apparatus has been completed.

Our second objective was to destroy icebergs with high explosives. The theory that the specters of the North Atlantic steamer lane could be blown to pieces has long been held by some men of science and of the sea.

ON THE SMALLEST SHIP THAT REGULARLY SAILS THE NORTH ATLANTIC

On the morning of March 21 the *Tampa* steamed out of Boston Harbor headed for the Grand Banks.

Like its sister ship, the *Tampa* is 240 feet long and 39 feet in breadth—a tiny chip compared to the giants it is set to watch. She suggests a staunch-hearted but ineffective Jack-the-Giant-Killer when beside a berg 700 feet long, 250 feet wide, and 200 feet high.

Nevertheless, our ship, which is the smallest vessel that regularly sails the North Atlantic beyond the Banks, is exceptionally seaworthy, capable of withstanding the gales and heavy seas for which the North Atlantic is notorious.

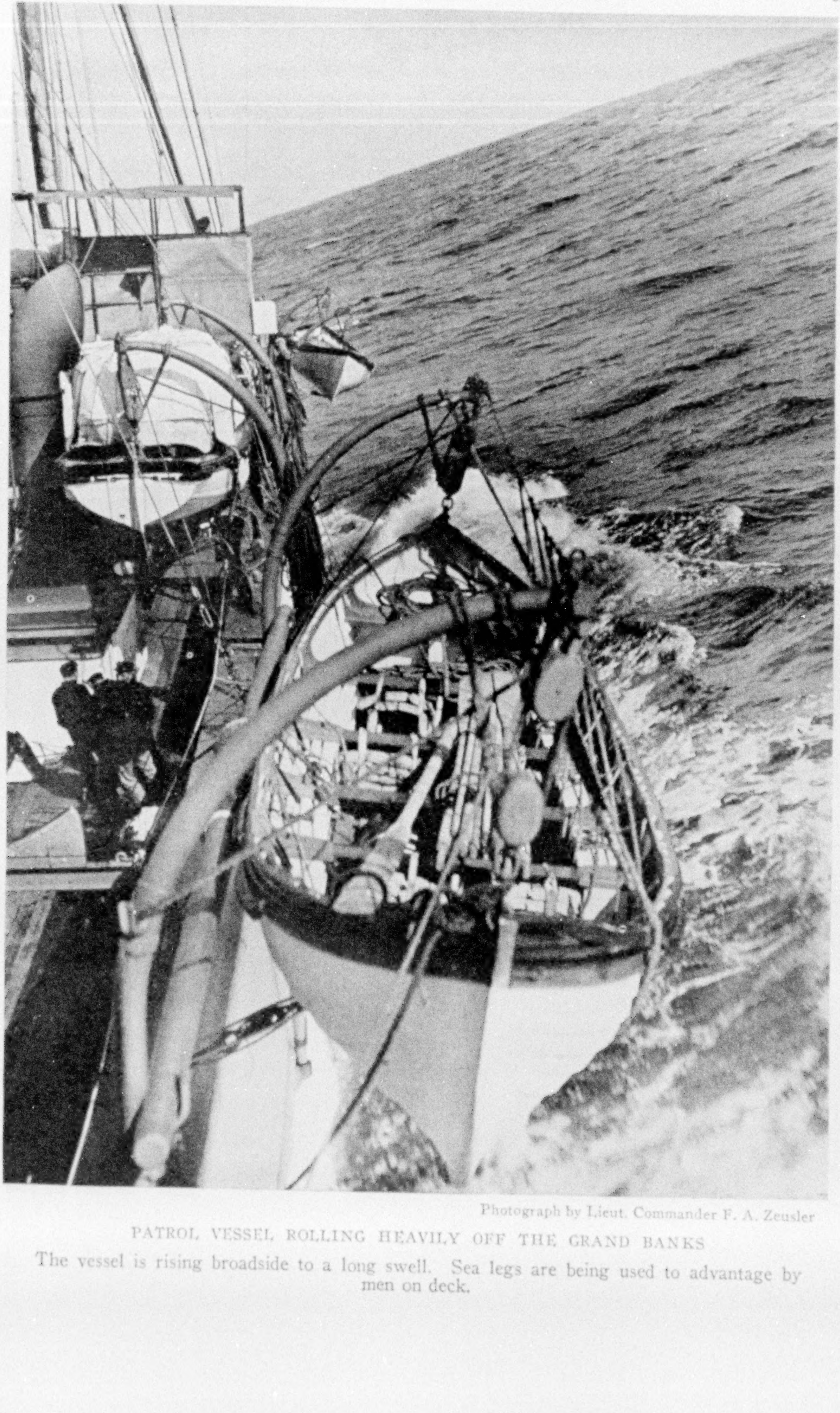
The vessel is driven by electricity and is very quiet, only a light whir rising from the propelling machinery. Everything is clean, because we burn oil. The motors can send our ship at fifteen knots.

The berth deck is next above the engine room. Eighty-four men of the crew have their mess, reading tables, and bunks aft. Here are held movie shows every other night, when sea conditions permit.

On the same deck forward are quarters for the ten officers. The galley and the captain's cabin are on the main deck, and above them the radio room and the navigator's room.

We can expect good things from the galley, often the fine fish of the Banks, given to us by friendly French fishermen.

Although we go on a peaceful mission, the *Tampa* is well armed. There is a five-inch gun forward and another one aft. In addition, there are two six-pounders



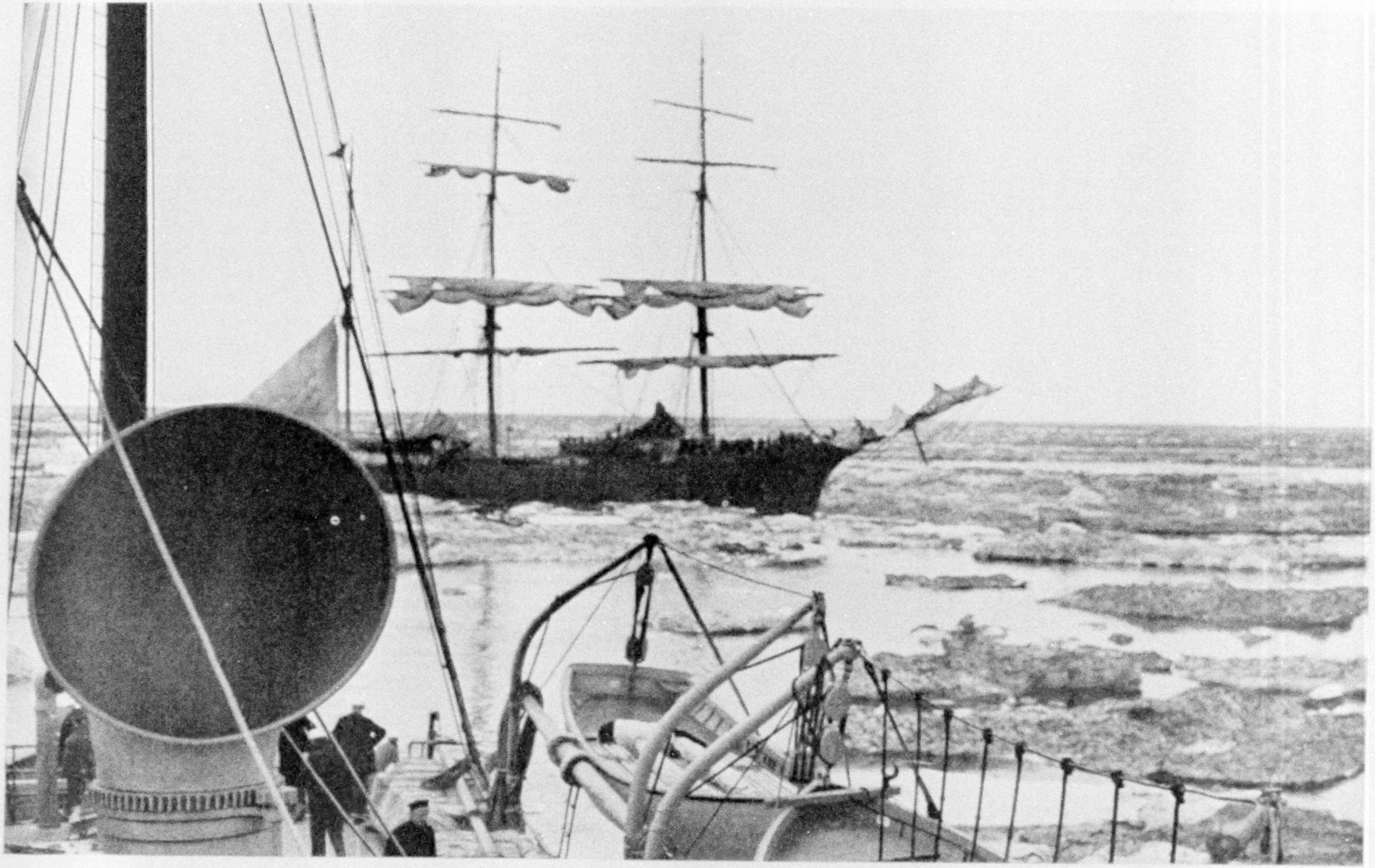
Photograph by Lieut. Commander F. A. Zeusler

PATROL VESSEL ROLLING HEAVILY OFF THE GRAND BANKS

The vessel is rising broadside to a long swell. Sea legs are being used to advantage by men on deck.

Photograph by N. Brunilla

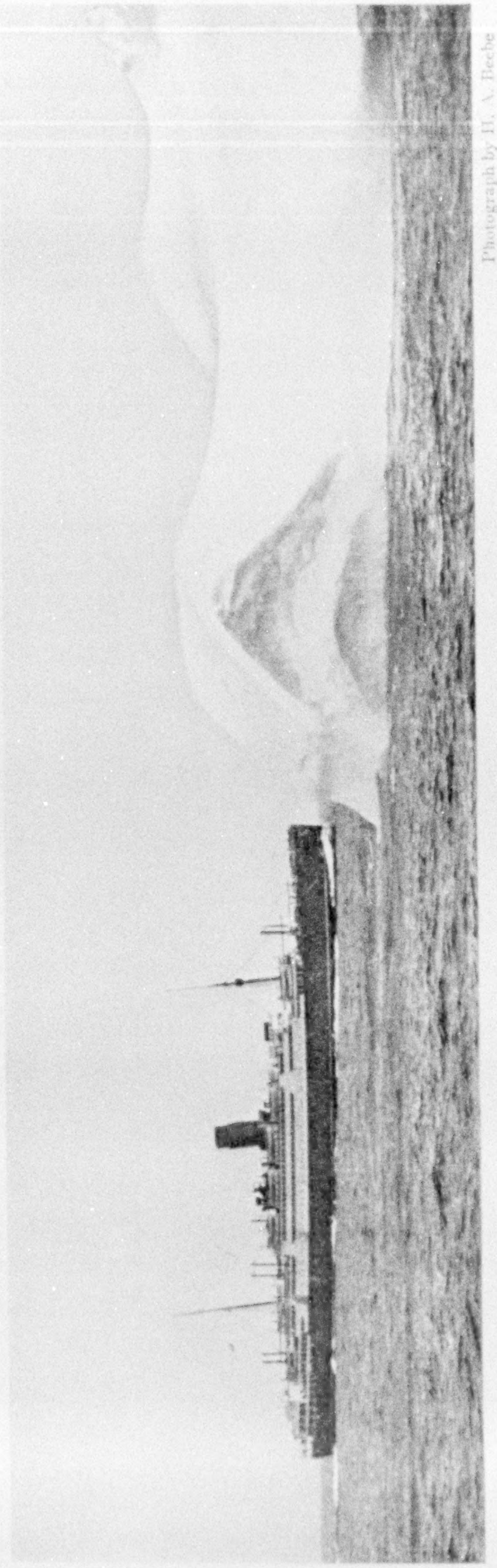
RIDING THE MASSIVE WAVES LIKE A DUCK: GRAND BANKS, NEWFOUNDLAND



Photograph by Lieut. Commander F. A. Zeusler

A FISHING VESSEL CAUGHT IN FIELD ICE

Among the numerous fishing craft encountered on the Grand Banks are many from the Brittany Coast of France.



Photograph by H. A. Beebe

A LARGE BERG WHICH HAS TOPPLED OVER

The near-by steamship *Tuscania*, which is 575 feet long, affords a convenient "yardstick" by which the iceberg can be measured.

for saluting and a three-inch anti-aircraft gun.

THREE RADIO SETS CARRIED

Our radio equipment is of particular interest. In addition to a radio compass, there are three sets: one a 2-kilowatt vacuum-tube set, with which we can communicate with the shore and with vessels fitted with modern equipment; second, a 2-kilowatt spark set, with which we can communicate with vessels carrying old-fashioned equipment; and, third, a 50-watt short-wave vacuum-tube set, used for experimenting in code with amateurs and for telephoning to the *Modoc*.

Our radio duty is truly international, for we speak in code to ships of all nationalities.

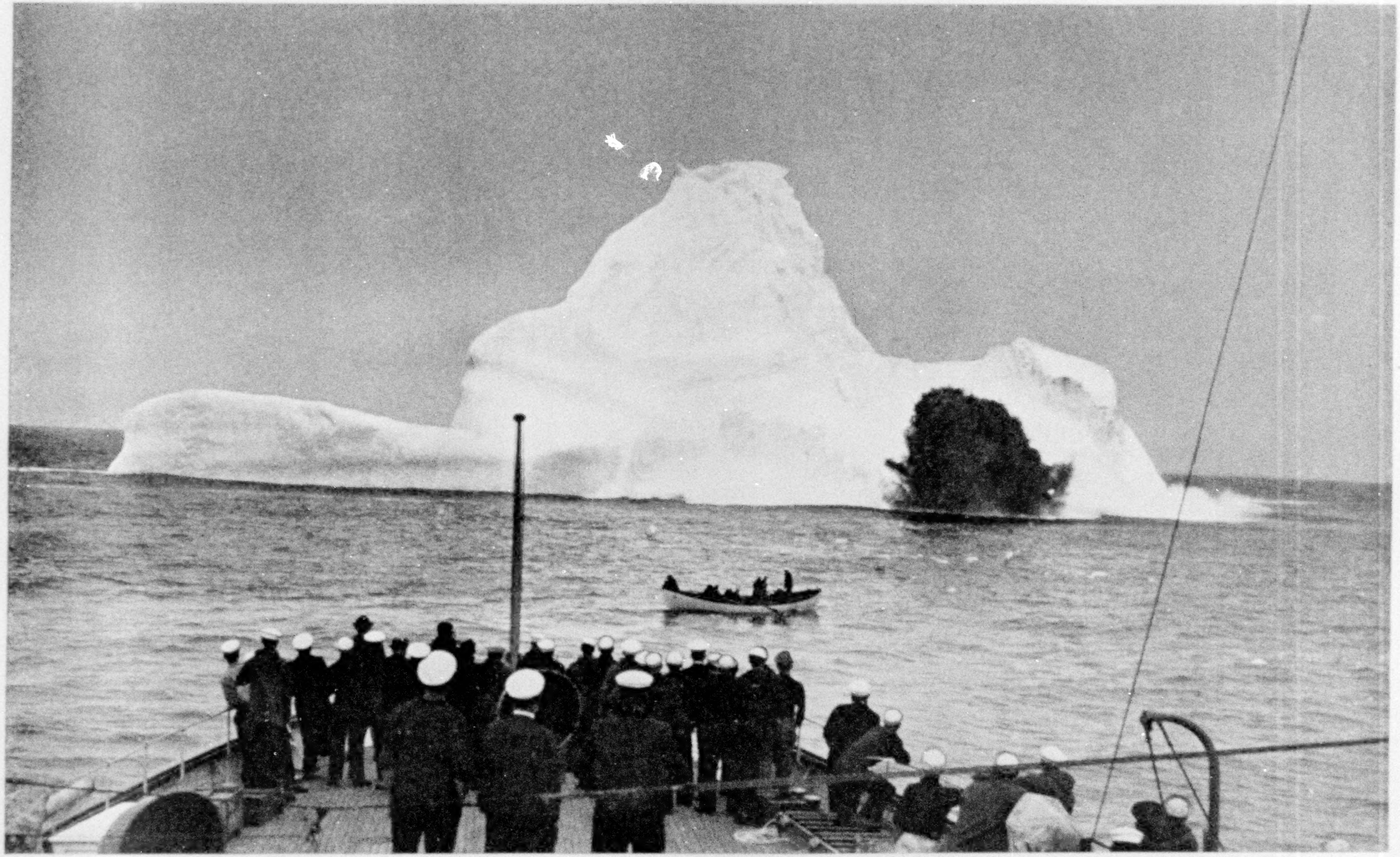
Two days out of Boston we broadcast an announcement that the Ice Patrol for 1925 is starting. We ask for water temperatures and send a query for any reports of icebergs.

A "How do you do" message goes to the Canadian land stations at Cape Race and at Chebucto Head, near Halifax; to the French station at St. Pierre, the United States Naval Station at Bar Harbor, and the station at Chatham, Massachusetts. These stations answer immediately, assuring whole-hearted coöperation.

The cutter on duty is a busy place every day. To carry out the orders, "to locate the icebergs and ice fields nearest the transatlantic steamship lanes, and to determine the southerly, easterly, and westerly limits of the ice as it moves to the southward, and keep track of all ice seen or reported," is not an easy task.

THE OCEANOGRAPHER BEGINS HIS DAY'S WARNINGS

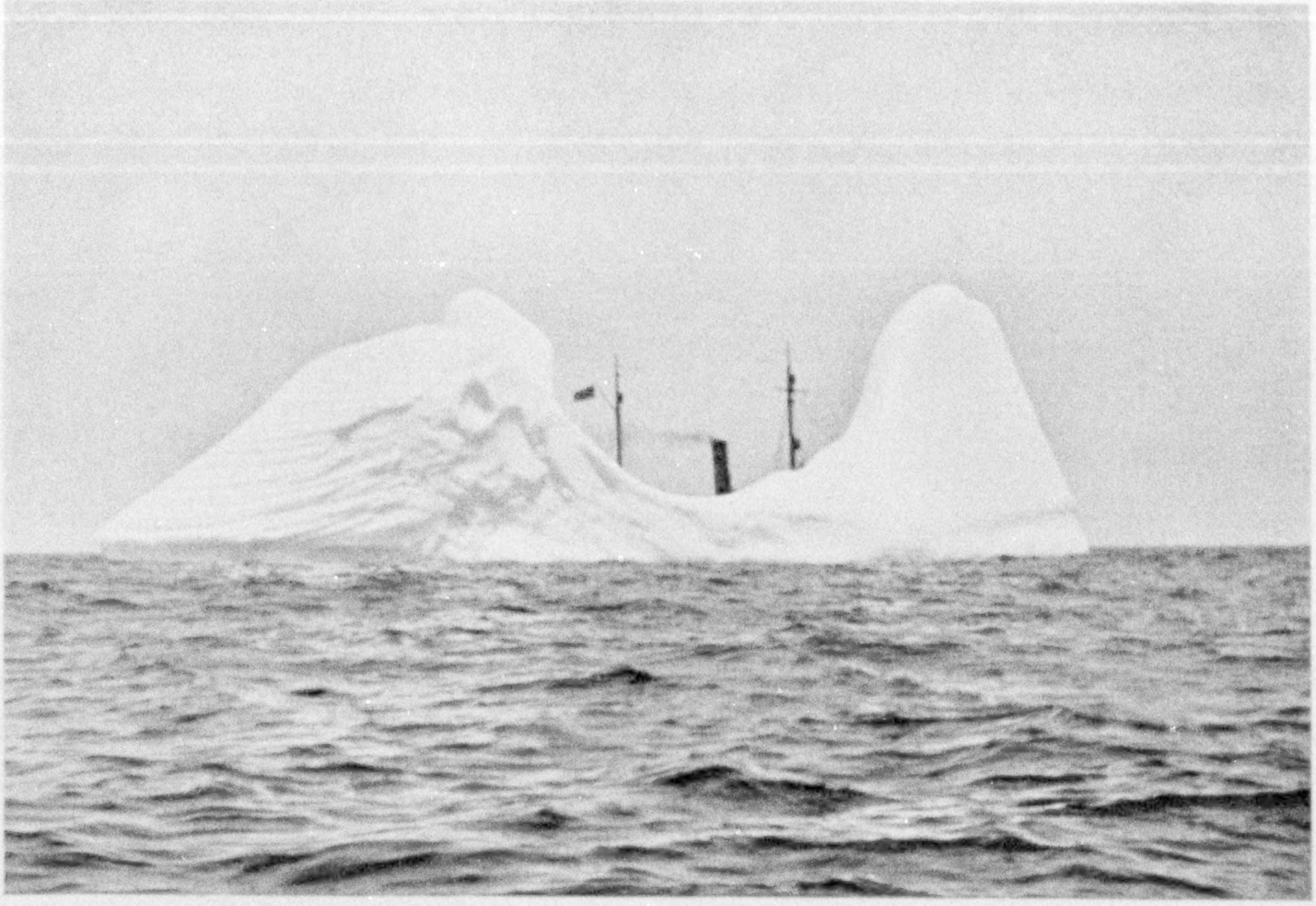
The oceanographer's day begins before the break of dawn, because he must get star sights for position if the fog permits, the first of the series to be made and checked all during the day.



Photograph by N. Brunilla

THE "MODOC" STANDS BY TO OBSERVE THE EFFECT OF AN EXPLOSION OF A MINE ON A BERG (SEE PAGE 27)

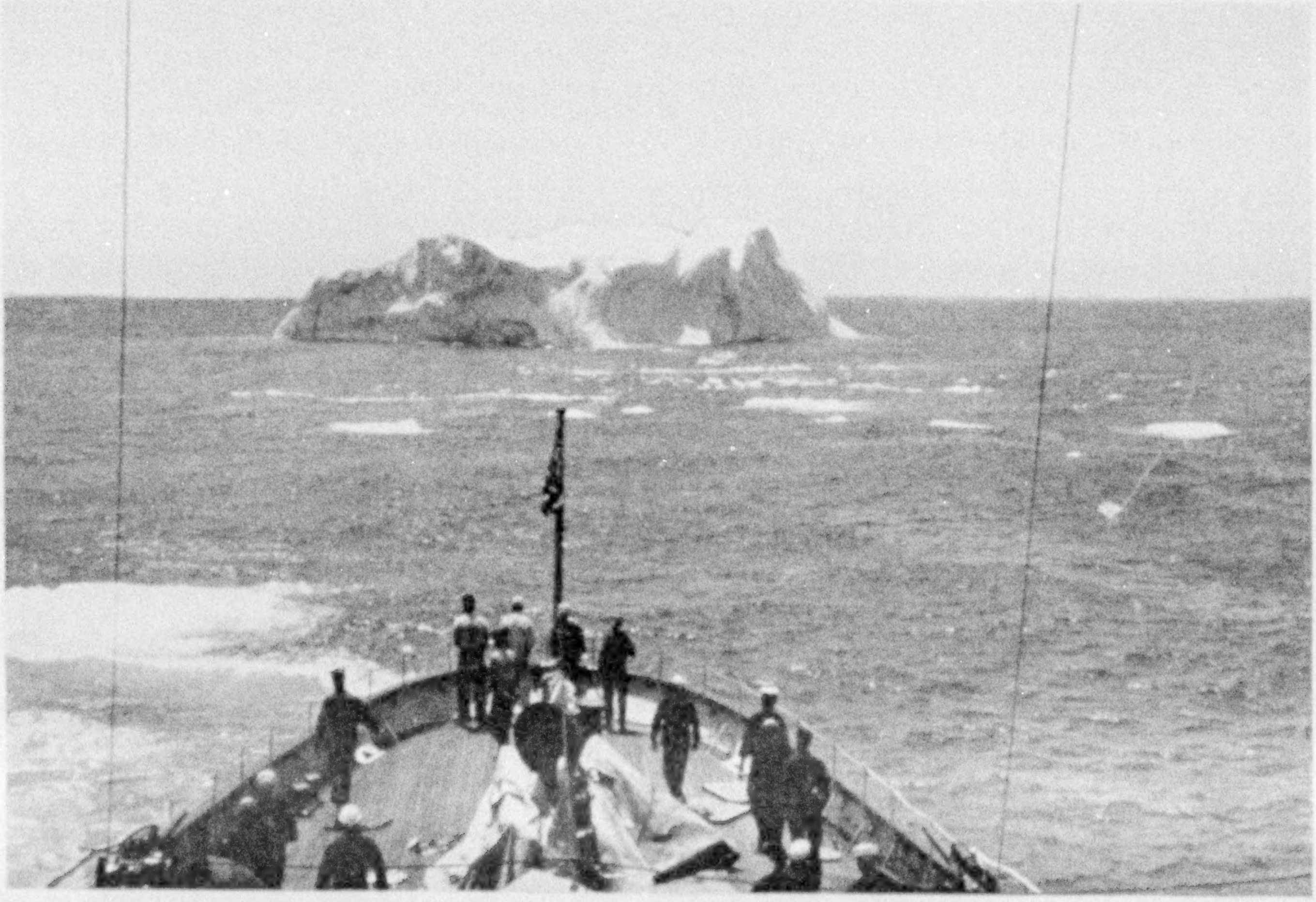
The damage was negligible. A column of water, a dark smudge, a fall of loose ice, and a slight tremor seemed to be the only results obtained.



Photograph from Lieut. Commander F. A. Zeusler

A BERG WHICH HAS RECENTLY CAPSIZED

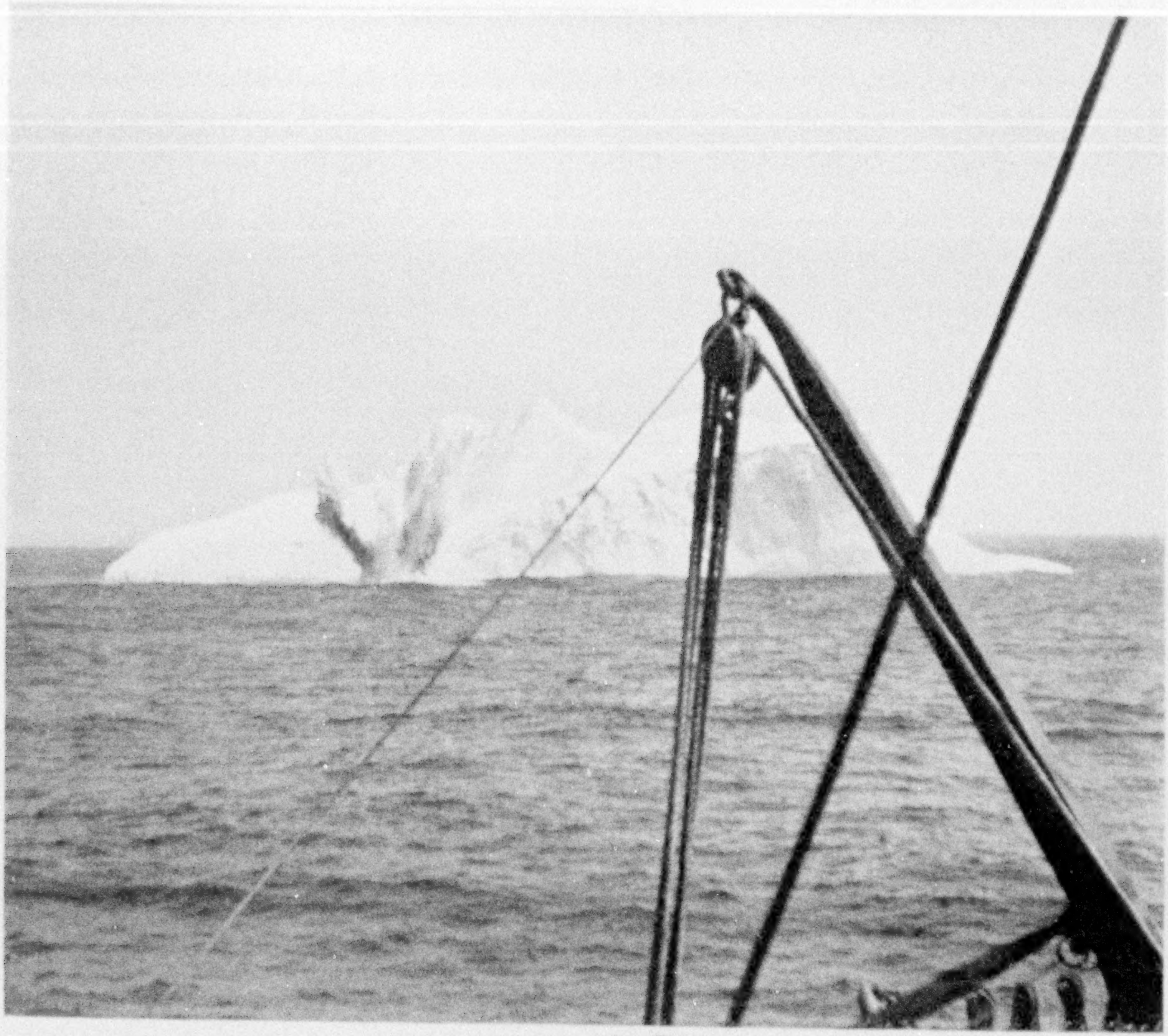
The fact that it has turned topsy-turvy is shown by the whole upper portion, which is water-washed. Note the ice sloughing off on the left-hand end.



Photograph by Lieut. Commander F. A. Zeusler

A SOLID BERG HAVING CAPSIZED, THE DETACHED ICE IS DRIFTING TO LEEWARD

A "growler" is seen near the stern of the vessel (see text, page 24).



Photograph from Lieut. Commander F. A. Zeusler

SETTING OFF TNT UNDER A BERG (SEE TEXT, PAGE 27)

At 6 o'clock the first ice broadcast goes out to the ships with modern equipment: "Patrol vessel near two bergs—latitude, 42° 30′; longitude, 48° 30′; set and drift, 180 degrees five-tenths of a knot per hour; foggy, smooth sea." Added to this will be the position of perhaps twenty other bergs.

The set and drift data enable the ship navigators to know that the two bergs, which are the two southernmost, are coming south at the speed given.

Queries flood the cutter after the ice broadcast has gone out and continue all through the day.

"Where is the southernmost ice?" is a familiar message from the *Tuscania*.

"Is there any ice to the northeast of us?" asks the *America*.

"Is there any ice below latitude 47?" comes from the *Aridiano*.

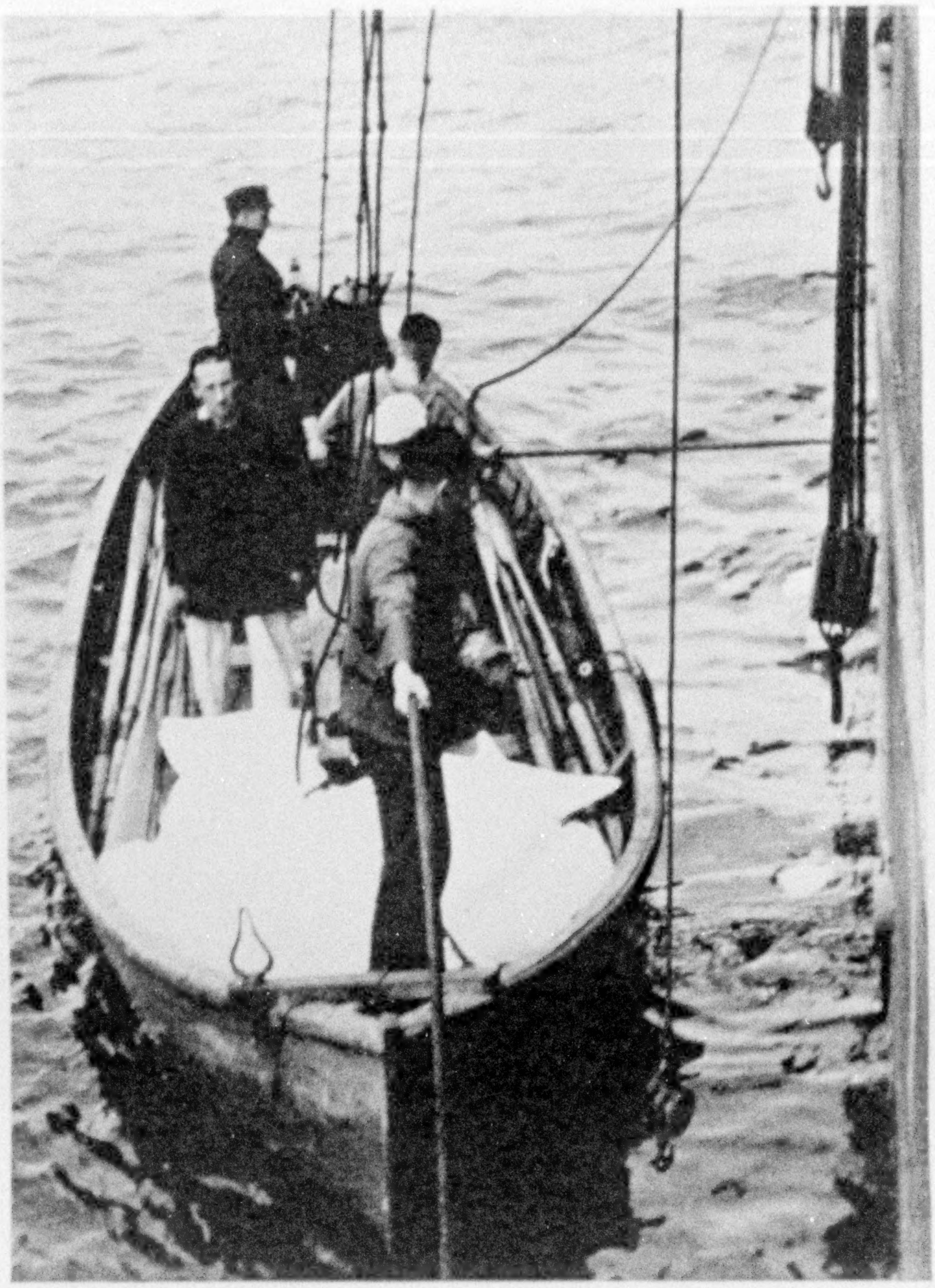
"I am in a dense fog in latitude 47° 10′, longitude 49° 35′; what is my best course to clear the ice?" asks the steamer *Emanual Stavirondis*.

"What are the latest weather and ice conditions?" asks the *George Washington*.

The oceanographer notices, while plotting the water temperature, reports from the *Megantic* and the *Kurdistan* that their present courses might carry them close to a number of dangerous bergs. An ice warning is immediately dispatched, which the vessels acknowledge with thanks. The vessels alter their courses to clear the ice.

THE ICE PATROL CUTTER IS THE TRAFFIC OFFICER OF THE SEA

On the great steamer lane between Europe and America liners, cargo carriers, and tramps pass constantly. It is an avenue of the sea just as much as Michigan Boulevard or Fifth Avenue is a heavy traffic street. On what is known as the "westbound tracks" are the ships coming from Europe, and on the "eastbound



Photograph from Lieut. Commander F. A. Zeusler

GLACIER ICE FOR REFILLING THE REFRIGERATORS OF THE PATROL VESSEL

tracks," 60 miles south, are the ships going to Europe.

All vessels off the tracks are reported for violation of the rules. A vessel off the track is just as dangerous as an iceberg or a derelict. Boulevard speeds obtain, so that the fast liners "step on it" through all kinds of weather.

The Ice Patrol cutter stands as a traffic officer on this avenue of the sea. If the ice threatens blockade, the cutter sets the stop sign and turns the traffic into a "side street" detour to the south.

Like a good traffic officer, the cutter answers all queries about the condition of the "road" and will help a ship in trouble. On one day we may hear from as many as 38 vessels, all within close range. This does not account for all the ships passing, for many do not reply to our broadcasts.

Since dawn of our typical day on ice patrol, the ship has been searching the danger area. If it is the last part of the season, we are at the southeast end of the Banks.

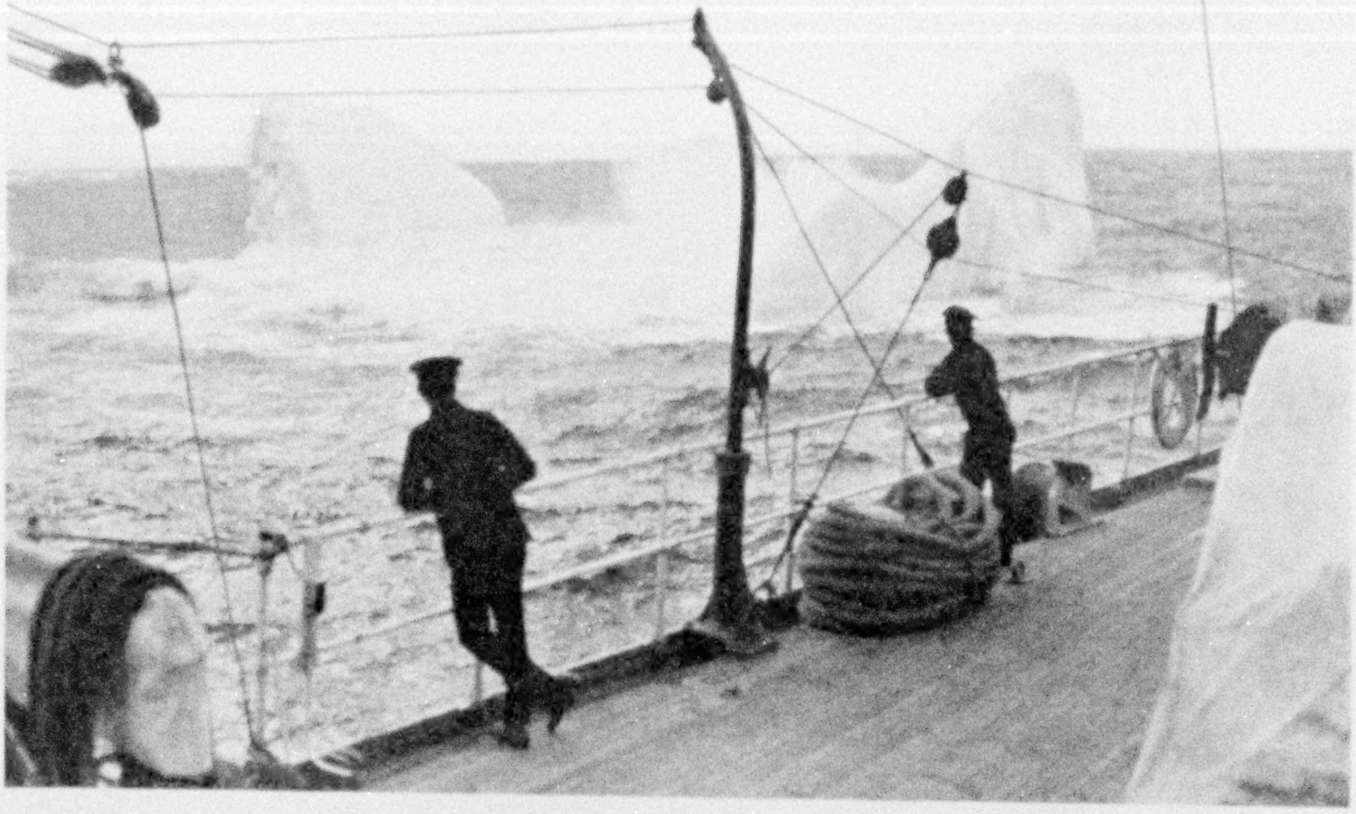
We steam 30 miles north, and since there is no fog or haze, we command a view of 15 miles on each side. Then we turn east at right angles for 30 miles more. Another right-angle swing heads us south for a 30-mile run, after which we again turn east, repeating the rectangular methods of searching until nightfall.

DAILY NEWSPAPER GETS ITS DISPATCHES FROM ARLINGTON

But let us return to some morning duties not yet completed. The big vessels got our 6 o'clock broadcast. It must be sent by spark set to the other vessels, on a lower wave-length, at 7 o'clock.

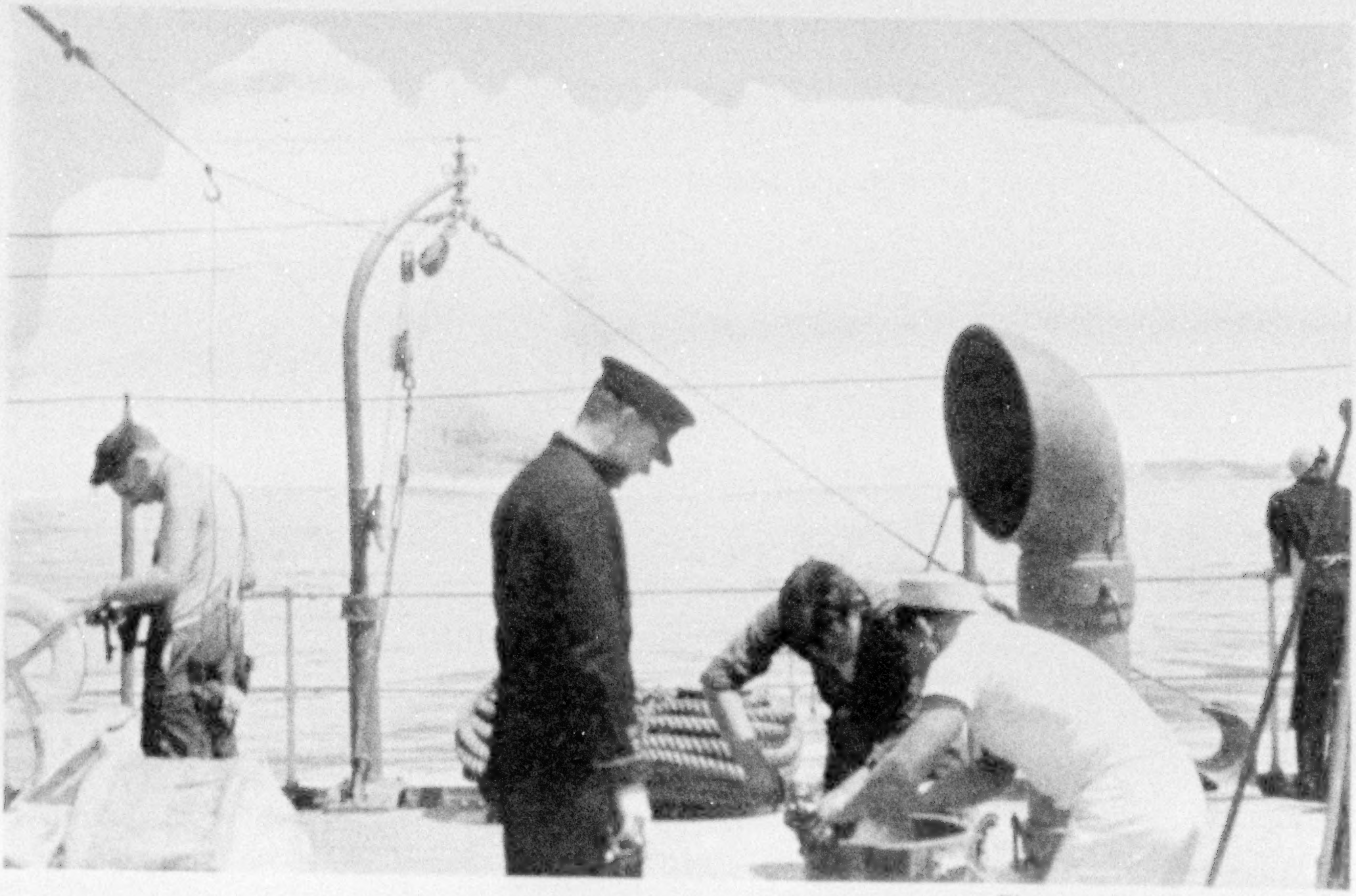
After the 7 a. m. broadcast comes morning mess, at 8 o'clock, and with it the Ice Patrol *News* (on the *Modoc* this is better known as the *Modoc Bull*). Our press news is almost as hot as our coffee, for the radio operator got it from Arlington at 1 a. m. Baseball for the Ice Patrol *News* sport section is in greatest demand, so the Big League diamond news is delivered on the Grand Banks in full.

On shore are many complaints these days, decrying the fact that the public never feels the personality of newspaper editors. This charge cannot be brought against the *News*, for the particular prejudices of the radio operator and the



A SMALL DRYDOCK BERG BEING SUBJECTED TO THE BATTERING OF HEAVY SEAS

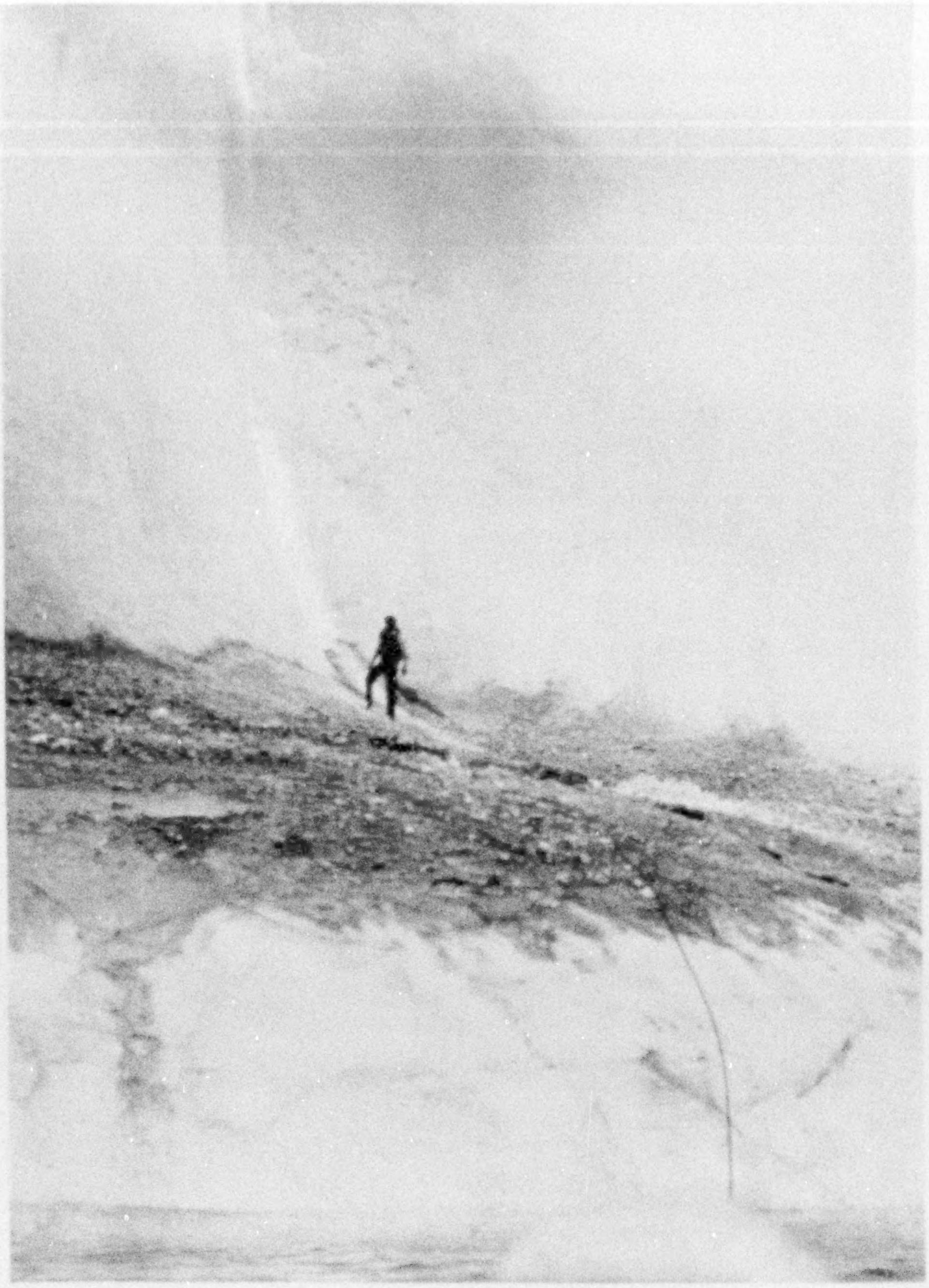
This type of berg is a sturdy sailor and is more dangerous than the oscillating solid type (see text, page 24).



Photographs by H. A. Beebe

MAKING ICE CREAM

The "ice plant" for the occasion is the massive berg alongside.



Photograph by Lieut. Commander F. A. Zeusler

EFFECT OF THE EXPLOSION OF THE FIRST MINE (SEE TEXT, PAGE 28)

Note the mine cable, by means of which the charge of explosive is fired, leading to the boat.

crook of his funny bone largely determine the contents of the journal for the morning. It is a very informal newspaper, with witticisms punctuating the paragraphs on Mr. Dempsey or the latest frolics of Hollywood.

The reports, received from large and small vessels alike, scatteringly through the day, give their position, direction of course, speed, weather, water temperature, and ice report, if any. The oceanographer takes sheaves of these reports to the chart room to locate the vessels and determine whether their courses threaten to bring any one of them into danger.

Three separate charts are plotted recording the ship's ice and water temperatures. The latter is very important, because by using from 900 to 1,300 messages in 15 days we can locate the "cold wall," the line of demarcation between the warm Gulf Stream water and the cold Labrador Current water.

This line is, indeed, the danger line, because icebergs that are perils to shipping seldom cross it. The location of it at the beginning of the season is an index to the severity of conditions to be expected.

A berg that crosses the line commits quick suicide, for water at 55 to 60 degrees melts ice very rapidly. A big berg will disappear seven days after it crosses the line.

The cold wall is also normally the southernmost fog line, another factor that makes its determination doubly important. We watch the cold wall push down until the last of April; then we record its recession, as the power of the Gulf Stream pushes it back north.

COLD WALL SEPARATES WATER VARYING 20 DEGREES

Twice this morning we have crossed the cold wall. It is easy to see. North of it the ocean is a beautiful olive green, south of it the water is indigo blue. The higher content of microscopic marine life gives the Labrador Current its olive-green tone.

The prow of our cutter can be in green water of 40 degrees Fahrenheit, the stern in warm blue water that registers 60 degrees. Since it is a beautiful day, the captain stops the ship to grant swimming liberty to all hands. The crew dives off the stern into tropical-temperatured water, while half a mile away to the north floats a large iceberg, drifting in cold water.

Mid-afternoon we sight an iceberg which has not been seen hitherto. It is a new charge, so we must go over and investigate. We approach close enough to make photographs and sketches from two sides.

We also take observations to determine its dimensions — that is, length, breadth, and height above water. From these figures we can gauge roughly the total mass, for always one-eighth of an iceberg is exposed. Next we take temperatures at the surface and at five different depths and get samples of water for salinity determination.

These data enable us to predict in what direction the berg will move. We figure also the rate of drift and the direction of movement, and this information is then transmitted in a special ice broadcast.

Photograph by Lieut. Commander F. A. Zeusler

THREE-MASTED FRENCH FISHING VESSEL "EMILE CAREY," WITH HER DORIES

This ship received a visit from the *Modoc*, which accepted a present of a halibut. The physician of the Ice Patrol cutter treated a number of sick fishermen (see text, page 21).

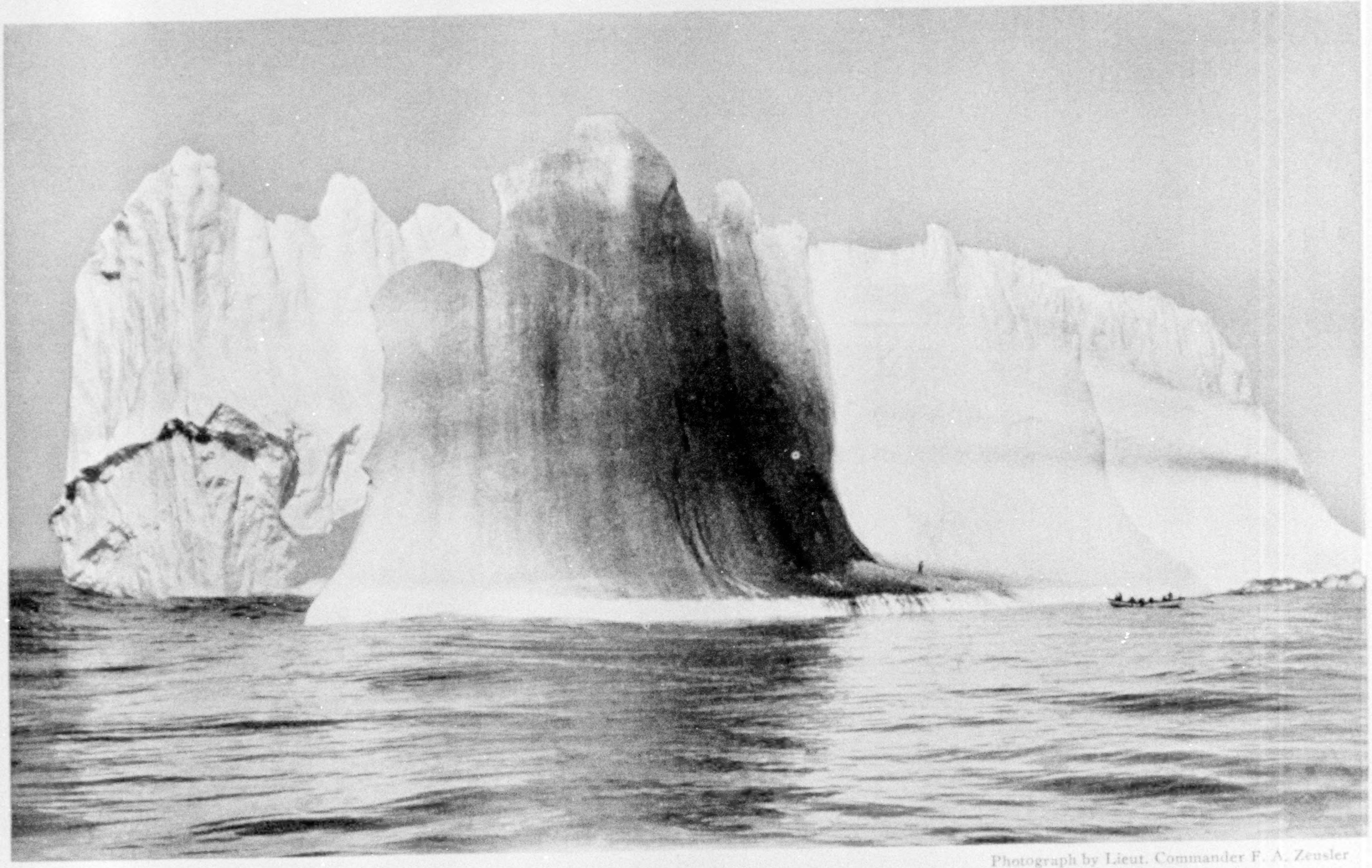
ICEBERG EMITS A SIZZLING SOUND

Since we are in need of ice for the refrigerators, the captain orders a boat lowered and dispatched to the berg. Ice of an iceberg is pure and fresh (see pages 16 and 17).

As the boat approaches the floating ice island a sizzling sound becomes audible to the men. Close attention shows that this comes from small pieces of ice slipping off into the sea. Unlike ordinary ice lumps, the pieces effervesce. This is a peculiarity of glacial ice, due, in all probability, to the fact that it is compacted of snow.

At evening we stop the engines and drift, keeping the berg in sight. Two broadcasts again go out, first to the ships with modern equipment and second to the smaller ships, with old-style sets. Following this an ice message, and weather report giving our own weather and weather reported as far east as possible, go to Washington.

The weather reports furnish important data for predictions, both in North America and Europe, since we are the only



Photograph by Lieut. Commander F. A. Zeusler

SMUDGE FROM THE EXPLOSION OF A MINE PLACED ON THE SURFACE OF AN ICEBERG LEDGE

No apparent damage was done to the berg, but a large hole was blown into the ice (see text, page 28).

regularly reporting station in mid-Atlantic with the exception of the *Jacques Cartier*, the French weather-reporting and training ship, which is usually stationed in about latitude 38° 00′ north, longitude 57° 00′ west.

Thousands of Americans sailed to Europe last spring. Few of them were aware, as they retired to their staterooms at night, of what precautions were being taken for their safety. They did not know that in the radio room on the upper deck of the *Leviathan*, the *Berengaria*, the *Belgenland*, the *Rochambeau*, the *Veendam*, the *Rotterdam*, the *Albert Ballin*, the *Paris*, the *Aquitania*, the *Volendam*, the *Olympic*, the *Esthonia*, the *Montcalm*, the *Thuringia*, or some other of that swift corps of liners, a message from the *Tampa* or the *Modoc* was coming in, telling about fog and icebergs.

Nor did they realize that their liner was reporting to a Coast Guard cutter drifting on the Grand Banks, so that officers on the cutter could check to learn if the liner's course was entirely clear of danger.

Next day the searching goes on, and the next, and the next. One morning our course carries us through a part of the French fishing fleet that has arrived on the Banks. We sight a sailing vessel and change our course for it. As the cutter approaches, the vessel maneuvers to check her headway. These French fishermen are finished sailors. They handle their sailing vessels as deftly as we do an automobile (see pages 19 and 25).

A two-flag signal, "RZ," rises to the masthead of the Frenchman. The "Esperanto" of the sea, the international signal book, translates this to mean, "What is my present position?" The sailing craft has been in gales, fog, and snow, permitting no opportunity to "shoot the sun."

Drawing alongside, our cutter displays a large paper with latitude and longitude marked on it. Down comes "RZ" and up goes "XOR" (Thank you).

This is only one of the many services we render the French fishermen. We try to meet them at least once a month. American and Canadian boats do not come this far out on the Banks.

The following day we come upon twelve French sailing vessels anchored in almost perfect formation, rolling incessantly in the choppy sea. We lower a boat and board the fleet.

How glad they are to see the cutter! Here is an opportunity to send mail to the families in Brittany. Usually a package of mail is being prepared the moment the patrol officer climbs aboard the vessel.

But they have other requests, too. One vessel wants to trade fish for tobacco, chocolate, and fresh meat. Another has a broken fog gun, that valuable piece of equipment which is depended upon to guide the dorymen back to the vessel from distances a foghorn cannot reach. We make the repairs quickly.

The three fishermen who board the cutter to help with the repairs are taken in tow by the enlisted men, shown a movie, given a big dinner with a menu they have not tasted for three months, such as eggs, ham, roast beef, potatoes, and cabbage. They go back to their ship rejoicing and promising to pray for us.

Still another French vessel needs medical aid for a fisherman with a broken arm and for a number of men suffering from "fish poisoning"—a blood infection having its origin in the work of cleaning fish. A fourth ship asks the use of our radio to report to its owners the loss of two men washed overboard.

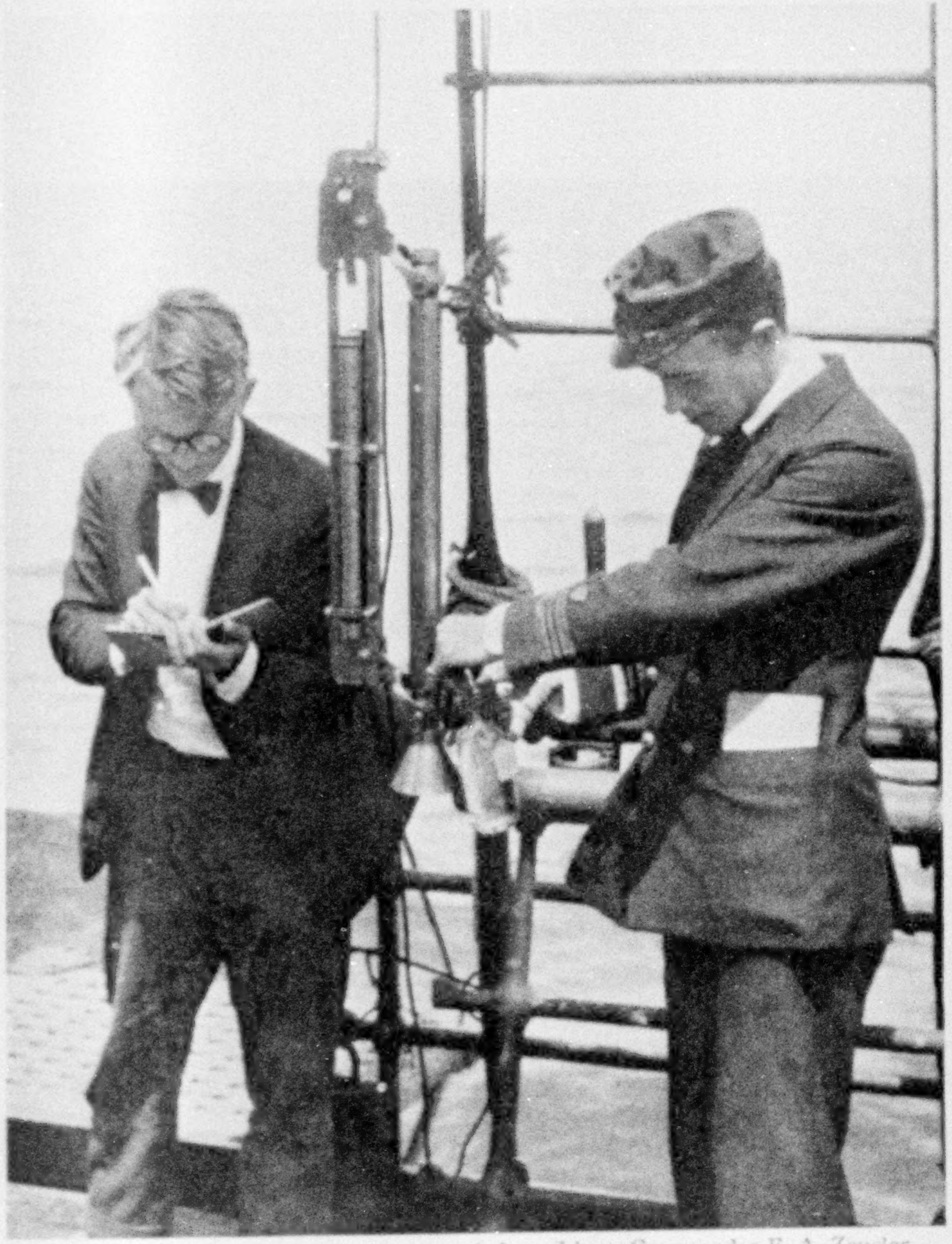
TWO TYPES OF BERGS—SOLID AND DRYDOCK

On April 13 we had the unique experience of sailing into a field of ice where 14 large bergs were in sight at one time.

There are two easily recognizable types of icebergs—the "solid" and the "drydock." The distinction is important, for the different types have different histories. The solid type is a solid block, often with the massive symmetry of a great block of white marble. It usually lies comparatively low in the water. Its sides are rounded by the action of the water, because it has tipped now this way and now that way (see pages 12 and 14).

Contrary to the general belief, icebergs do not frequently turn completely over. They will tip 90 degrees one day, and then perhaps the next swing 80 degrees in another direction, but they seldom turn turtle.

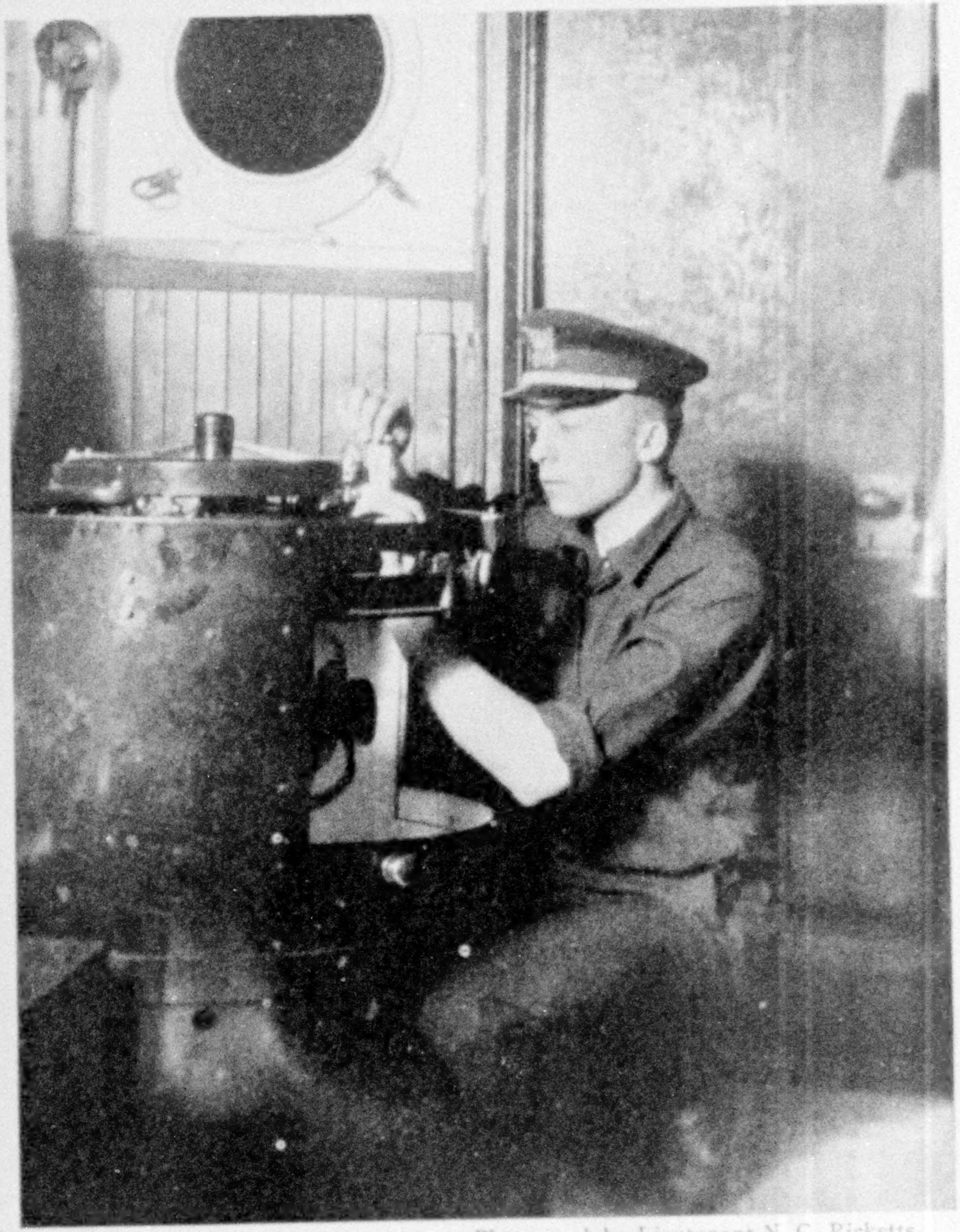
We get to learn much about the odd habits of icebergs. One we came upon had a regular oscillating movement. It



Photograph from Lieut. Commander F. A. Zeusler

READING THE DEEP-SEA REVERSING THERMOMETER

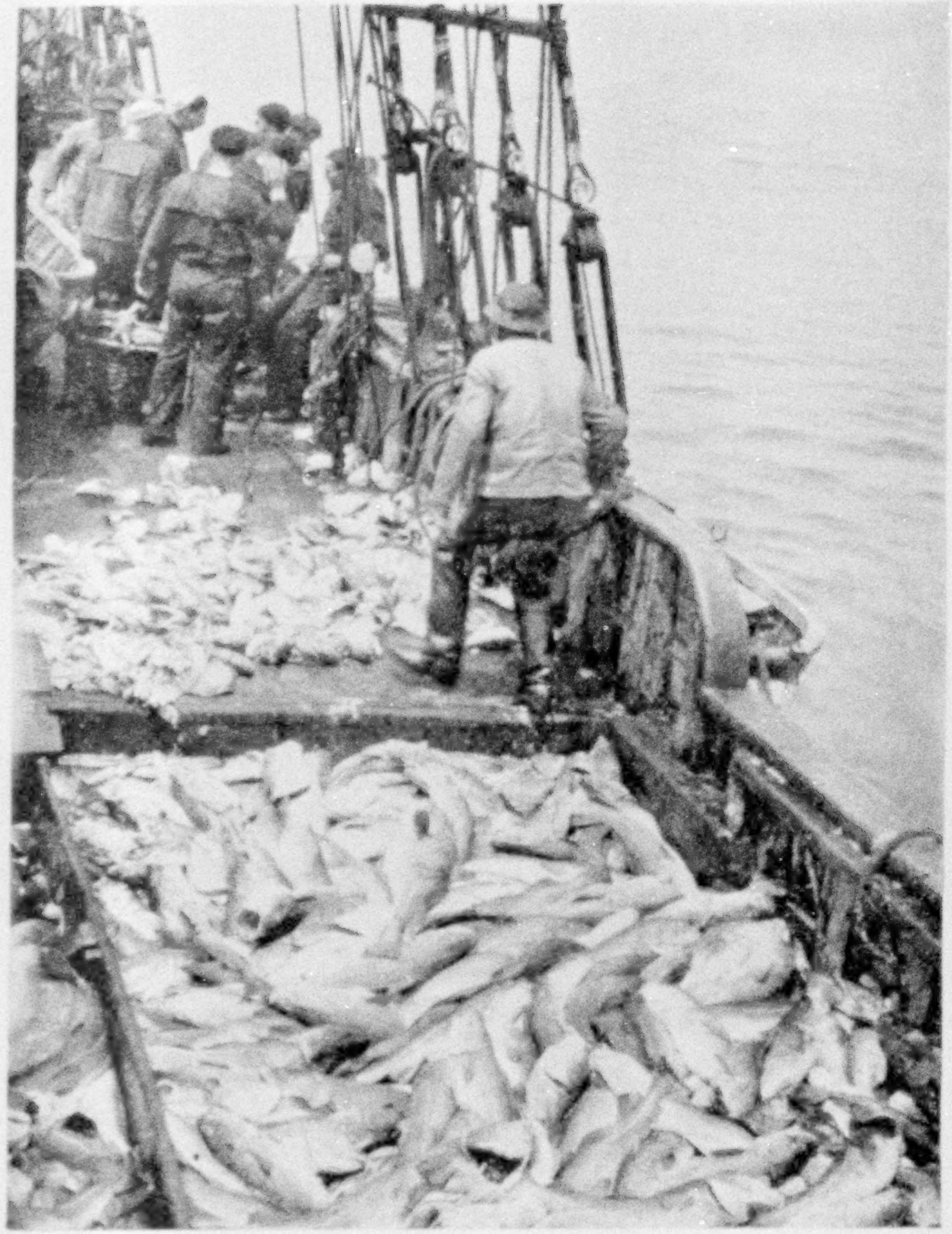
Thermometers are secured in the two parallel tubes shown with the holes at their upper ends. At the same time that the thermometers are tripped, recording temperatures, the chamber at the right-hand side of the instrument falls, securing a sample of the sea water. It is drawn off in bottles when brought on board.



Photograph by Lieutenant N. G. Ricketts

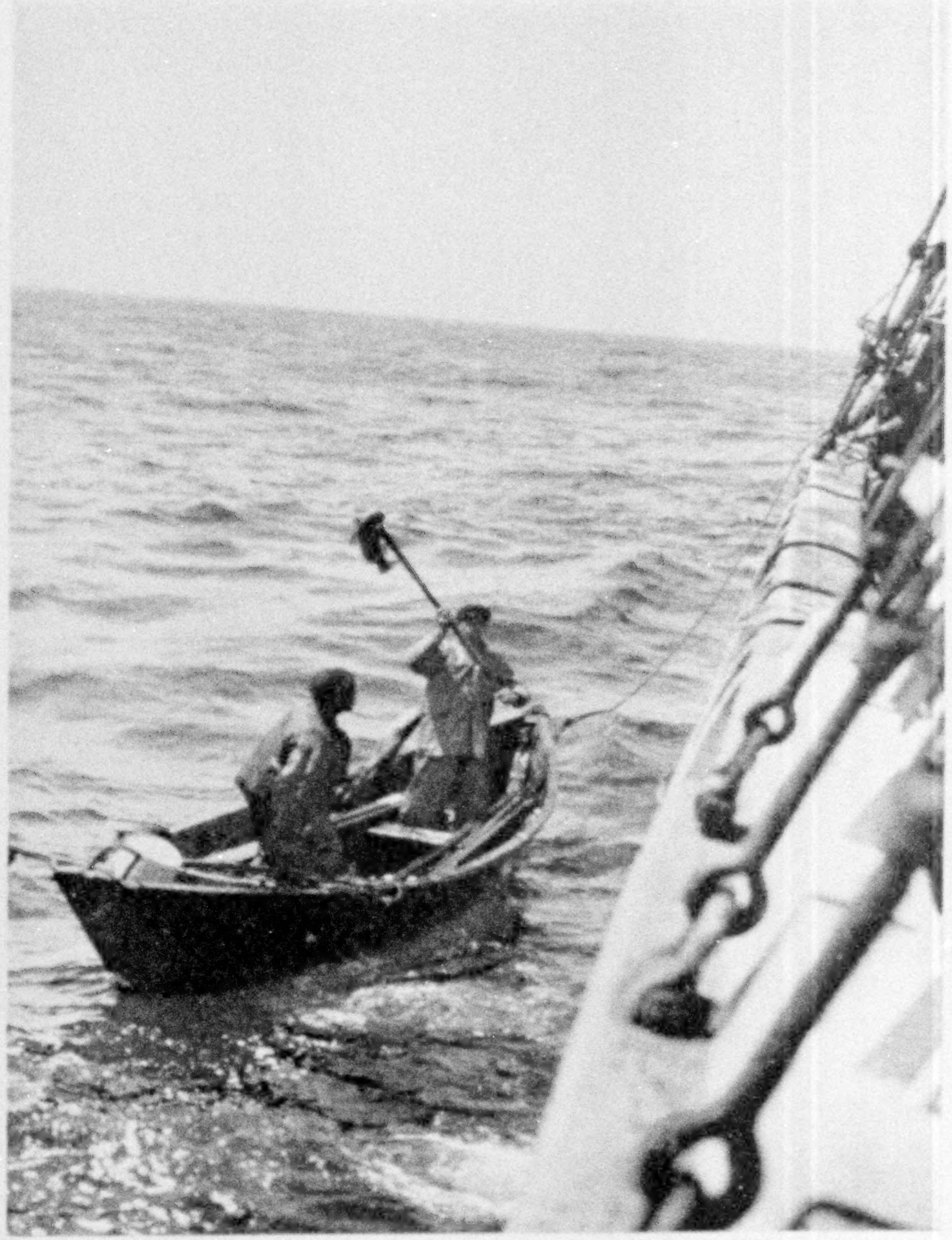
SETTING THE COURSE AND LATITUDE CORRECTORS

The gyro compass is an invaluable aid on ice patrol, where it is absolutely essential that the ship's position be known at all times accurately. This instrument is very reliable when properly cared for. It is a piece of "fancy machinery," however, comprised of wheels within wheels. This type, with the repeaters and recorder, cost $6,000.



COMMISSARY OFFICER OF THE ICE PATROL VESSEL BARTERS FOR FRESH FISH

The supply ship in this case is the French fishing vessel *Eugène Louise.*



DORIES BRINGING CODFISH TO THE MOTHER SHIP AFTER HAULING TRAWL

The codfish are pitchforked and thrown on board.

Photographs by Lieut. Commander F. A. Zeusler

Photograph by Lieut. Commander F. A. Zeusler

GYMNASTICS OFF THE GRAND BANKS

This young athlete of the Ice Patrol dares the other men of the crew to do this.

tipped over to one side during a period of eight minutes, and then tipped back again. This continued for seven hours. Then, with a tremendous crash, it fell over on its side, exposing its erstwhile keel.

The solid bergs assume shapes of sleeping dogs or lions, King Tutankhamen in his tomb, and perfect profiles. The drydock bergs, on the other hand, give us towered castles and lofty pinnacles (see pages 2 and 17).

The drydock type, as the name implies, consists of two high sides with a low passage in between. Sometimes this "valley" is awash. These bergs do not turn over, but sail on as majestically as a well-ballasted ship. The pinnacles are always sharp, as if cut by some giant ax.

Drydock bergs deteriorate chiefly by ice sloughing off the steep cliffs and the warm water eating away the water line, when the lightened berg rises, leaving series of water lines circling the base.

The bergs of the drydock type gave us most trouble last year, probably because they are such sturdy sailing craft that the sea cannot attack them as easily as it can their rolling brothers.

Icebergs are not all frosty white. Scattered through most of them are strata of deep-blue ice of varying widths. The effect of indigo blue contrasted against the soft white is startling and exquisite.

Smaller bergs, remnants of broken ice monarchs, are called "growlers." They are almost as dangerous to shipping as larger bergs (see page 14).

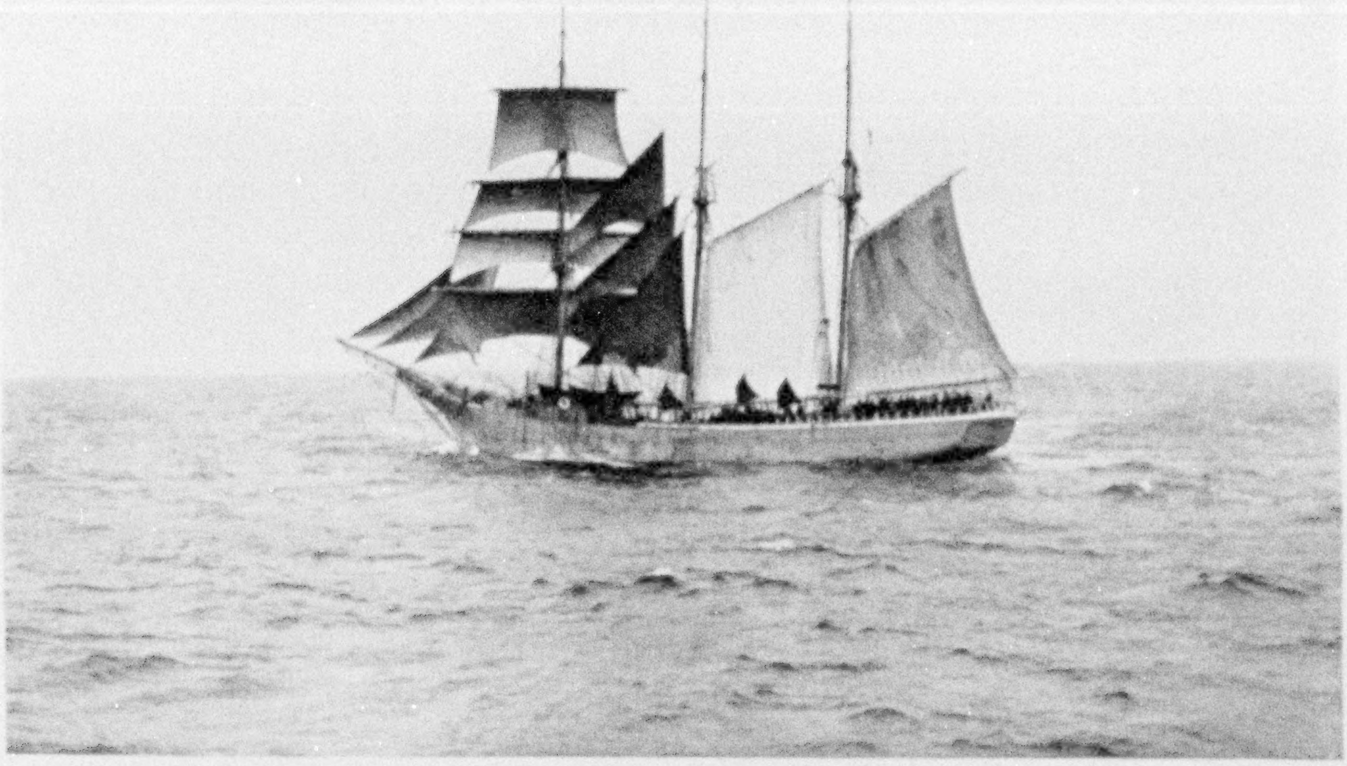
MEMORIAL SERVICES HELD FOR THE "TITANIC"

Tongues of ice project from the sides of most bergs. These projections are usually long, pointed ledges capable of mortally wounding any vessel that runs onto them. That one of these underwater daggers sent the *Titanic* to her doom is a tenable theory.

On April 14, the day following our sight of the berg field, memorial services were held on board the *Modoc* for the *Titanic*.

The crew was called to quarters on the quarter-deck, while the church pennant was raised on staff above the American flag. The ship's surgeon spoke to us to the accompaniment of a biting northeast wind howling through the rigging; the commanding officer led officers and men in prayer, and three rifle volleys barked across the water.

All across the Atlantic ships silenced their radio for five minutes, at the request of the *Modoc*, to honor the memory of the liner and her 1,513 victims. A large iceberg close astern afforded fitting background for the service (see page 28).



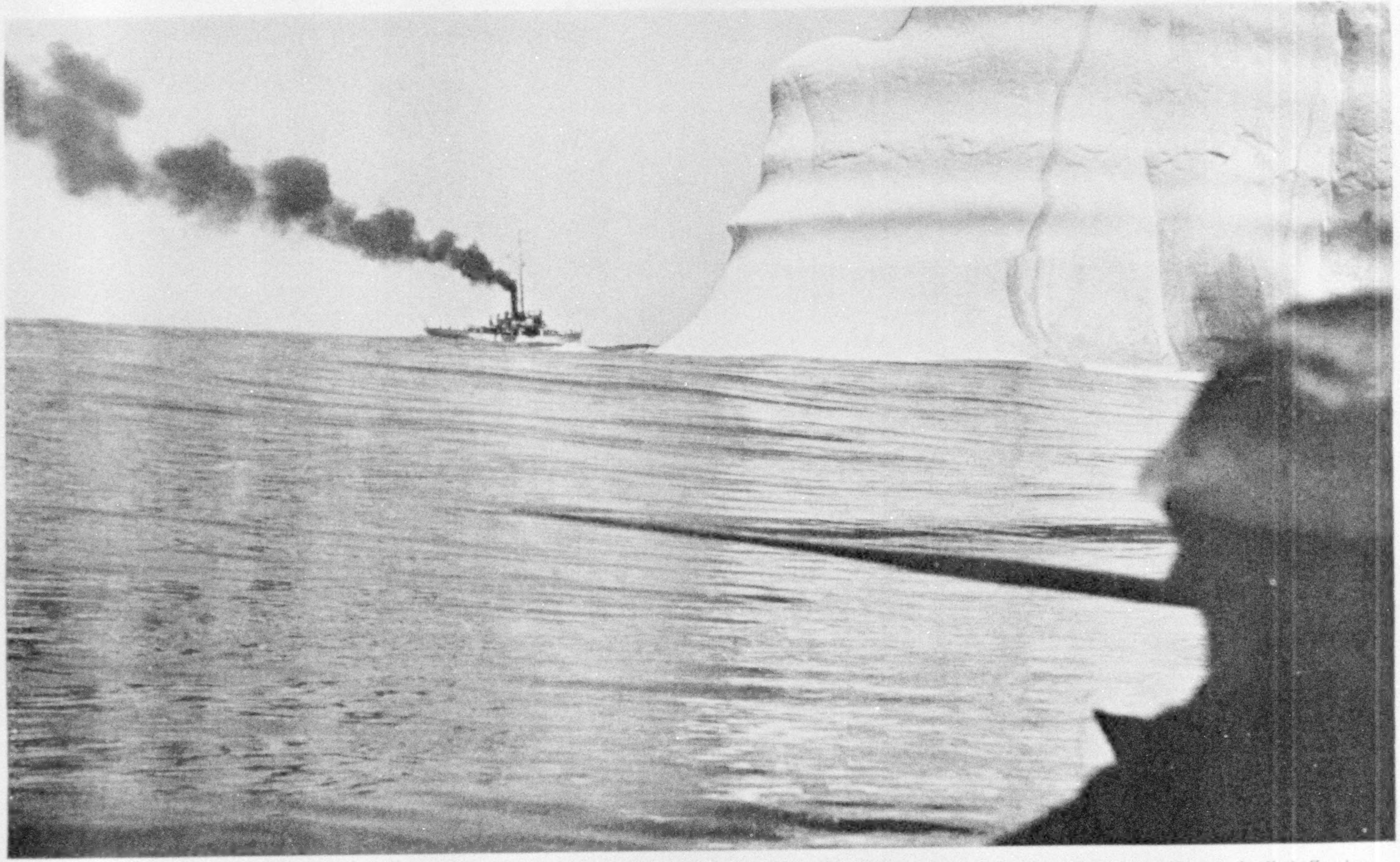
Photograph from Lieut. Commander F. A. Zeusler

THE "MODOC" GIVES THE CORRECT POSITION TO A FRENCH BARKENTINE (SEE TEXT, PAGE 21)

The *Viant*, of St. Malo, Brittany, is just arriving on the Grand Banks for the fishing season.

Photograph by Lieut. Commander F. A. Zeusler

FRENCH FISHERMEN ON THE GRAND BANKS BAITING TRAWLS



Photograph from Lieut. Commander F. A. Zeusler

AN ICE PATROL SHIP ROUNDING AN ICEBERG OFF NEWFOUNDLAND

The 1925 ice patrol season saw the first serious experiments to destroy icebergs by high explosives. Our first subject was a berg showing 10 feet above water, with a length of 50 feet, an "old" berg, honeycombed by weathering.

A commissioned officer and a boat's crew of eight planted 210 pounds of TNT under a ledge of the berg; then pulled away to a safe distance, reeling off the electric control cable as they went.

The officer closed a switch and a tremendous explosion shook the air and the water. One end of the berg fell off and the sea all about was afloat with small ice. We estimated that we cut two days off the life of this berg.

It was a different story when we tried TNT on a bigger block of sound ice. This next specter was 300 feet long and about 150 feet high. From one side projected one of the long, dangerous ice tongues, covered with about 10 feet of water. We laid the mines on the shelf and set them off.

The berg shivered, a shower of loose ice tumbled off the upper ledges, a geyser of water and black powder smoke went up 100 feet and came down, and the calm of Nature settled back upon the sea and ice. No damage.

Next we shot a line across the projecting end of the berg. On one end we attached the mine, lowering it to 75 feet below the surface and balancing the weight with a bag of iron on the other end of the rope. The explosion shook the berg more, but there was no perceptible damage. That charge would probably have given a mortal blow to the strongest ship afloat.

STANDING DEATHWATCH ON A BIG BERG

Our attempts to mine and destroy a third iceberg are of especial interest, because this was the largest that came into the steamer lanes last year, and because we trailed its steps to its grave from the time it was a strapping giant of a million and a half tons until it disappeared.

We first sighted the berg on May 26, well north on the edge of the Banks. It was christened No. 14. All bergs that are potentially dangerous are numbered.

No. 14 hugged the Banks and sailed southward at the modest rate of 21 miles per day.

After determining that there was only one more berg to the north, we steamed south and picked her up near the tail of the Banks on June 2.

We knew we were approaching No. 14 the second time before we could see her, because of a white line reflected against the clouds of the horizon. Soon the lookout shouted, "Ice ahead!" Although we were still more than 20 miles away, the topmost pinnacles could be seen, since No. 14 was 267 feet above the water.

As the ship approached in the calm sea and clear sky, the berg stood out shapely, fantastic, beautiful, and enormous in size. Closer view showed that it was drydock in shape, with two walls of uneven height. Both sides were 512 feet long—that is, the length of an average city block.

One of the boys on board was all for towing it down to Boston or New York and selling it to some ice concern. Indeed, its million and a half tons would supply New York's summer demand for two and a half months.

LEAVES FROM THE DIARY OF A BIG BERG

"*June 3.*—No. 14 heading right for the tail of the Banks. We hope she will ground because that will end our troubles.

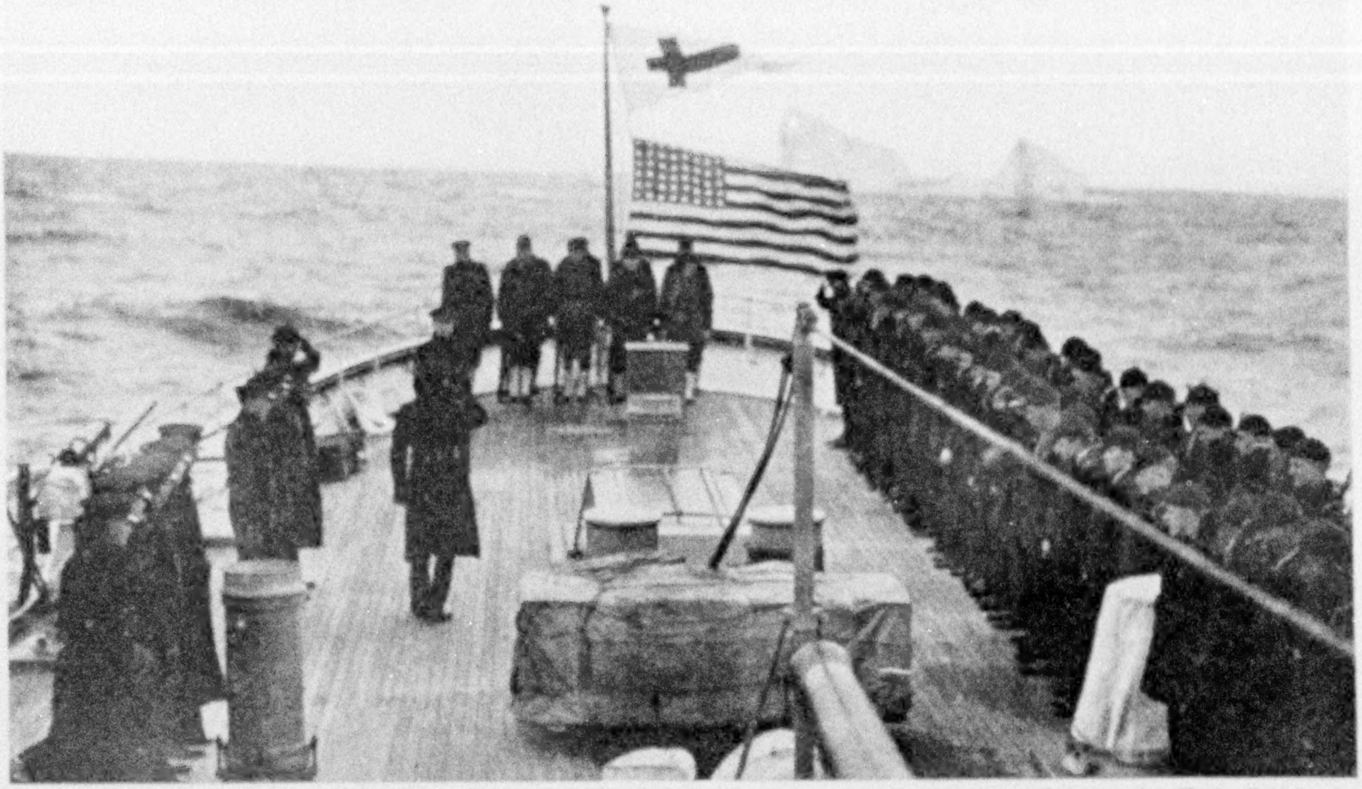
"*June 4.*—A heavy fog shut down, concealing our ward.

"*June 5 and 6,* the same. We estimate her drift, take a position 5 miles south, and shout to the world by radio that ice is north of us; take warning!

"*June 7.*—At 5:20 a. m. the fog lifts; sight No. 14 about 7 miles away. The berg looks the same until we approach, and then, without warning, the highest wall topples in with a crash that would awake the dead. It leaves a natural bridge across the 'drydock.' No. 14 has moved 60 miles south and west. To-day we are witnessing the beginning of the end.

"*June 8.*—No. 14 is now in 42 degrees water, whose warmth is undermining the berg's constitution. Learn this by watching the tilt of the water lines.

"*June 9.*—We decide to take a hand in the destruction of No. 14. First we explode mines on a tongue and then under water, as we did with the second berg, but with even less effect. Then we decide to try to dig a hole with four charges placed on a smooth water-polished shelf 40 feet wide terminating in a cliff 200 feet high.



Photograph from Lieut. Commander F. A. Zeusler

SERVICES FOR THE "TITANIC" DEAD

On April 14 each year memorial exercises are held on board the Ice Patrol vessel for the 1,513 souls who lost their lives on the giant liner destroyed by an iceberg in 1912.

"The berg is boarded with some difficulty, since the shelf has rounded edges. Without spiked shoes it would be next to impossible to climb on. Once aboard, steps are cut in the ice.

"The four explosions enable us to sink the last charge in a hole 15 feet deep and 20 feet across. Ice is tamped in over the charge, but the explosion only serves to paint a black smudge 100 feet wide, the whole height of the ice cliff" (see p. 20).

"The black banner serves as a handy identification mark. It is difficult to appreciate how resistant this ice is.

"Only one-half the length of a six-pounder projectile will penetrate into the ice when the shot is fired at 150 yards.

"*June 10.*—It is raining to-day and beautiful bridal-veil falls whisk off the cliffs of No. 14.

"*June 12.*—There is a heavy fall of about 20,000 tons of ice from the higher cliff. Perhaps this is a result of our blasting. No. 14 is now about 180 feet high and 450 feet long.

"*June 14 to 16.*—The berg teeters on the 'cold wall.' Finally it veers northeast into colder water. If it had crossed the 'line' it would have disappeared in about eight days. No. 14 saves itself from going directly into the steamer lane, which is very close here.

"We stand by all night playing our searchlight on the berg, because vessels are passing very close—some within half a mile.

"*June 19.*—No. 14 is having the fight of her life to-day. A strong southerly gale hits her. Heavy seas bombard the berg, throwing spray more than 100 feet in the air. We can hear the roar three-quarters of a mile away.

"*June 20.*—The storm has done far more damage than man's mines. No. 14 has lost both ends and much of her superstructure. She is now 250 feet long and 90 feet high.

"*June 24.*—The grave is opening for No. 14. One whole wall falls off. Her glorious cliffs are now gone, indeed, for the remaining side is tilted and awash. The water is 52 degrees. The Gulf Stream is getting in its work.

"*June 30.*—No. 14 shows up a lump the size of two office desks.

"*July 1.*—Six o'clock. No. 14 has gone where all good icebergs go. The Gulf Stream has avenged the *Titanic.*"

THE WORLD'S GREAT WATERFALLS

Visits to Mighty Niagara, Wonderful Victoria, and Picturesque Iguazu

By Theodore W. Noyes

WATERFALLS achieve greatness through a maximum combination of the factors of volume, height, breadth, and picturesqueness of form, coloring, and environment.

One class of falls finds greatness solely in the height of the descending column, like Yosemite, a creek 35 feet wide, which, with a vertical fall of more than 1,500 feet in its upper section alone, drops for half a mile into Yosemite Valley (see page 37).

It pictures to the eye a wavering, broken, silver ribbon, broadening at the bottom of its topmost section into a fleecy veil, disappearing in its middle section as rapids in rock fissures, and narrowing and deepening in its final drop to the floor of the valley.

Outlined against the side of the deep, broad precipice, it is dwarfed into insignificance by the immensity of the vast rock surface which environs it (see illustration, page 32).

At the other end of the line are falls like Niagara—low in height, great in breadth, vast in volume (see pages 42, 46, 47 and 48).

At Niagara the falling water dwarfs the precipice; at Yosemite the precipice dwarfs the waterfall.

Between the extremes of Yosemite and Niagara many of the world's notable falls find place.

Of the same type as Yosemite, of great height and small volume, are Roraima, in British Guiana (1,500 feet), Sutherland Falls, New Zealand (1,904 feet, in three sections) (see page 40), and Kalambo, South Africa (1,400 feet) (see page 41).

In an intermediate class between Yosemite and Niagara are fine falls of impressive height and considerable but not great volume, like Kaieteur (800 feet), in British Guiana, South America (see page 35); Nevada (600 feet), Vernal (317 feet), by which the Merced River descends into Yosemite Valley (pages 33 and 38), and Gersoppa Fall (830 feet), in India (page 34).

La Guayra Falls, in Brazil, have a great volume, but the Paraná River here descends from the Brazilian central plateau in a succession of short falls, separated by fierce rapids, no one of the cataracts being entitled to claim greatness (see page 53).

Many notable falls, from 300 to 400 feet high and of considerable volume, are found in widely separated corners of the earth, like the Lower Yellowstone Fall (300 feet), unsurpassed in beauty of form and in its setting of rainbow-colored cliffs (see pages 30 and 39); Grand Falls of Labrador (316 feet); Tequandema Falls (450 feet), in Colombia (see page 31); and Chamberlain Falls (300 feet), in British Guiana.

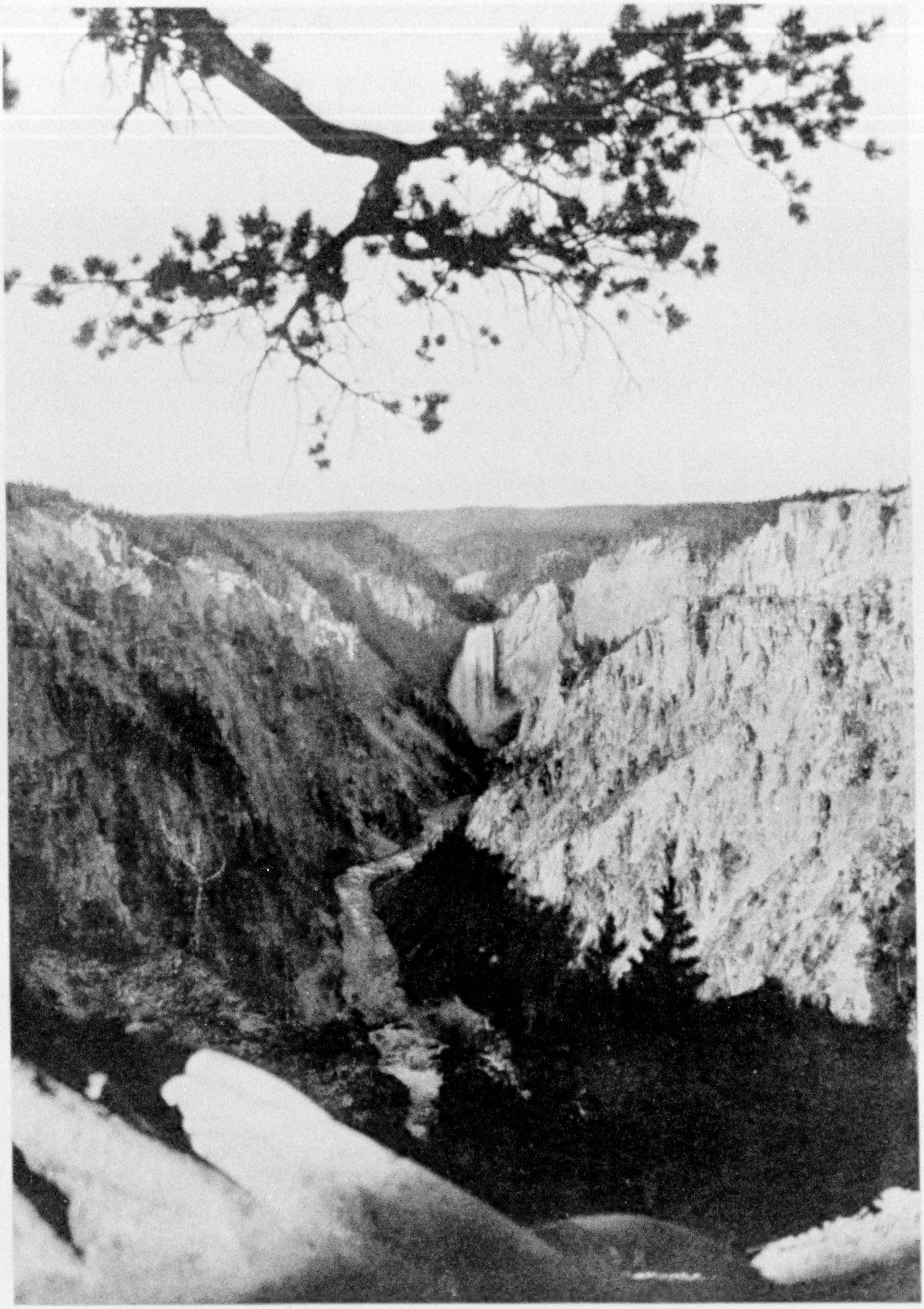
Some of the European waterfalls, noted in poetry and fiction, lack everything save beauty of form and artistic environment. Southey's Lodore, with its 157 varieties of descending waters, is more noted for the poet's verbal flood of descriptive adjectives and adverbs than for the water flood of the tiny cascade.

Three waterfalls which include all of the specified factors of greatness, though in varying degrees, are entitled to be classed among the really Great Falls of the world. These are Niagara, in North America; Iguazu, in South America, and the Victoria Falls of the Zambezi, in South Africa.

I visited Victoria Falls for one week in September, 1911; Iguazu for one week in July, 1924, and Niagara many times, most recently in May, 1925. Memories of each of them are deeply impressed, never to be obliterated.

NIAGARA, THE MIGHTY

In the interior of the North American continent, between Lakes Erie and Ontario, over a precipice bisected by the



© Asahel Curtis

THE GREAT FALLS OF THE YELLOWSTONE, UNRIVALED IN GORGEOUSNESS OF SURROUNDINGS

The color and wild grandeur of its setting make this cataract one of the most imposing in the world. The Lower Fall, here seen from Artist Point, has been compared to "an enormous, fluffy, endless pouring of whitest snowflakes." For 300 feet the river leaps with a roar to the floor of the prismatic canyon, dashing its waters into whirling spray and streamers of mist (see, also, page 39).

United States-Canadian boundary line, falls Niagara, the world's most famous cataract.

A million springs pour half the fresh water of the world into the basins of the four great lakes which are Niagara's sources. As the vast inland sea of Superior fills and overflows its basin, the waters descend and mingle with those of Huron and Michigan, and the three lakes pour the combined flood of their overflow into Lake Erie.

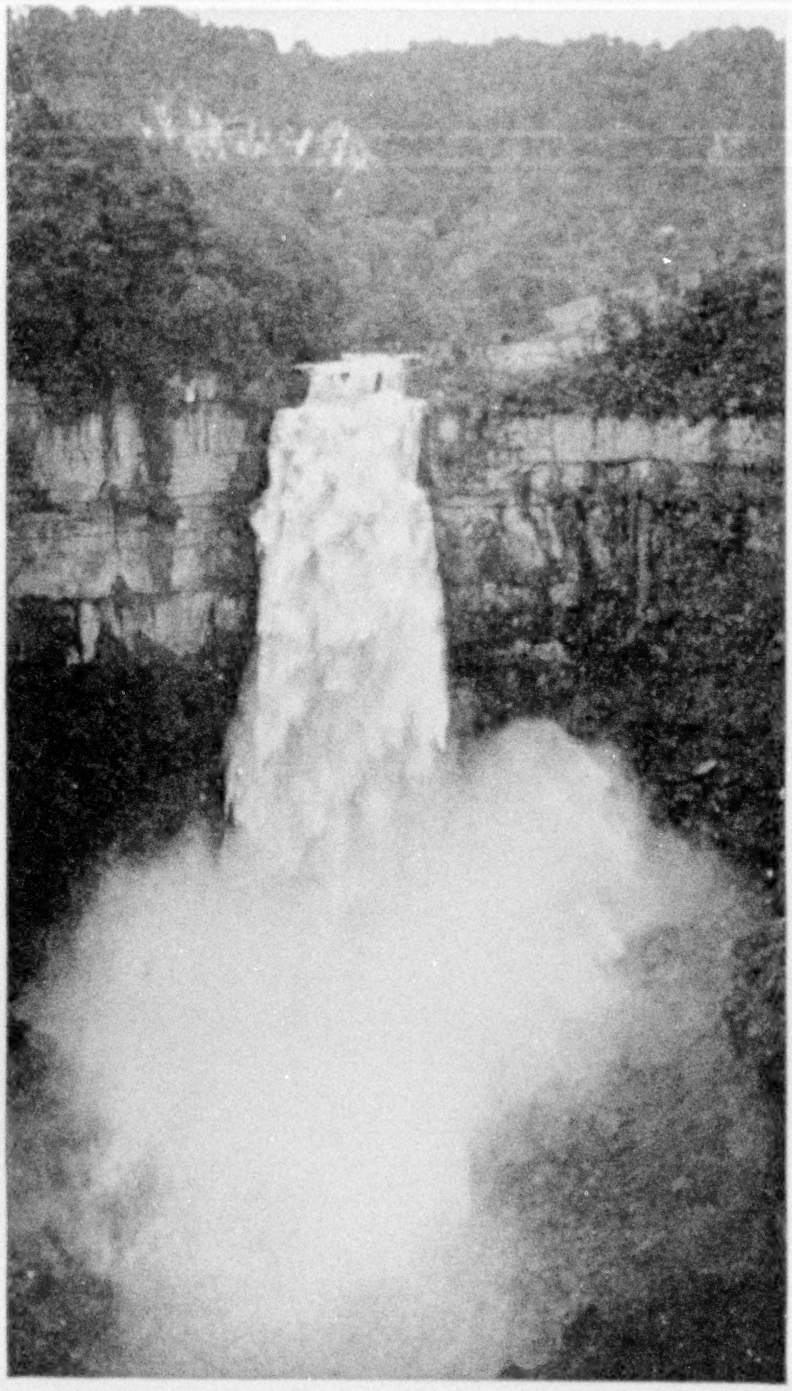
The vast aggregate volumes of the four great lakes, seeking from their elevated plateau sea level and their ultimate goal the ocean, break through a notch in the east rim of Erie's basin.

In a comparatively narrow channel, contracting from over two miles to one mile in width above the Falls, and to a few hundred feet below, these waters descend leisurely and smoothly for half of their 36 miles of journey to Ontario; then rush for a mile or two in white-capped, mountainous waves of fierce rapids; then plunge in a majestic fall into a chasm of a mile's contour in irregular semicircle at the precipice edge; then, cramped within narrow limits by precipitous banks, they rage in whirlpool and whirlpool rapids; and finally resume their dignified, unhurried pace for the rest of the way to Lake Ontario.

THE FALLS AND CHASM OF NIAGARA

Shortly before the precipitous cliff over which the Niagara hurls itself is reached, an island (yclept Goat) separates the river into two channels, about 6 per cent of the water passing to the right, over the so-called American Fall (167 feet high), in a symmetrical sheet about 1,000 feet wide, and the remaining 94 per cent to the left, over the Horseshoe, or so-called Canadian, Fall (158 feet high), in 3,000 feet of irregular and semicircular distorted outline. Goat Island, separating the two falls with 1,300 feet of precipice edge, completes Niagara's mile of contour.

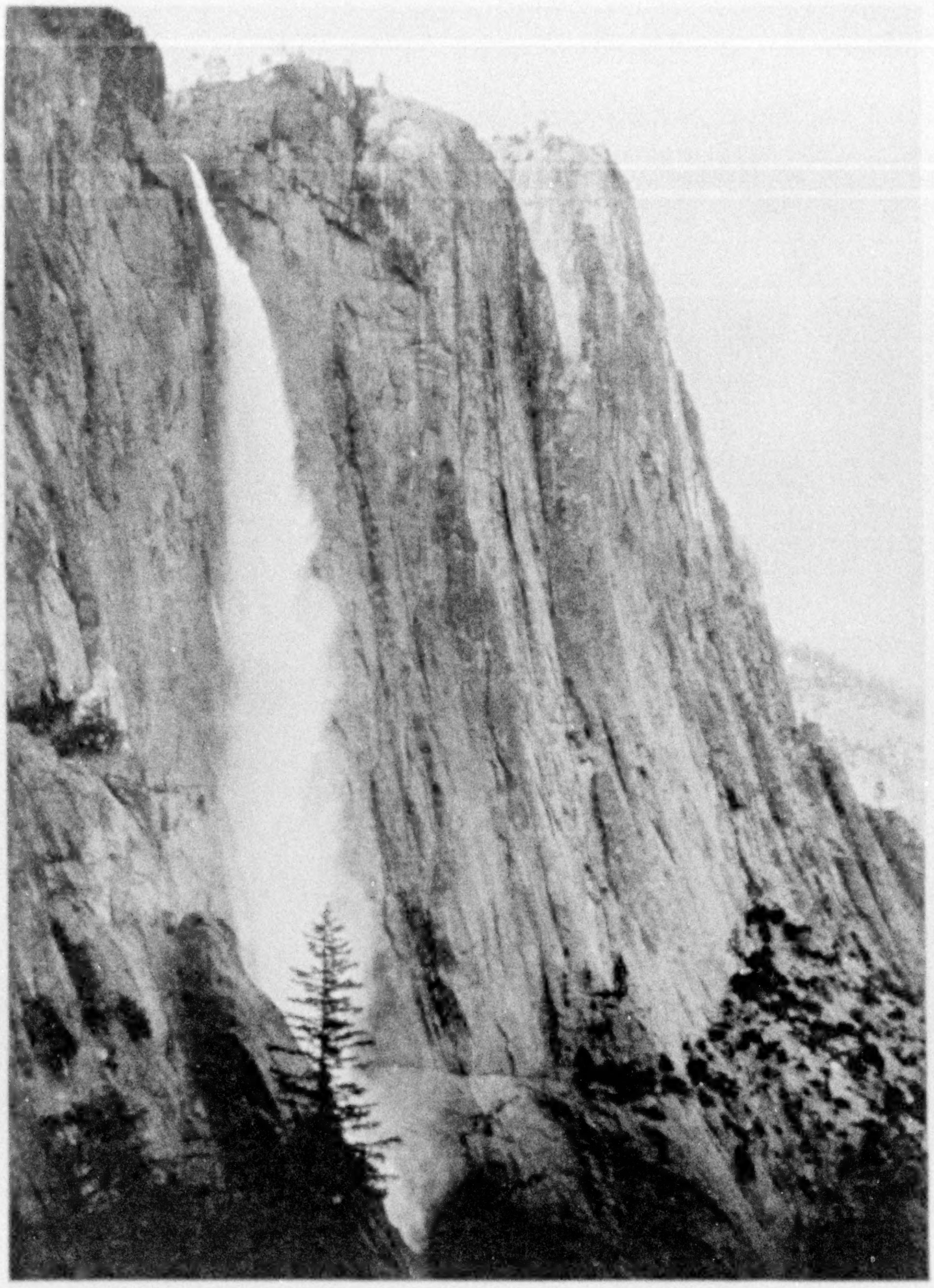
A whole library has been printed concerning Niagara. Artists and word painters, eloquent prose writers, poets of high and low degree, have vied in accurate and vivid picturing of its wonders. It is easily accessible and the average American and many travelers from abroad have seen it. Minute description of its grandeur can convey no conception to him who is a stranger to its wonders. To those who know it well such description is superfluous.



Photograph by Joseph E. Pogue

THE SEETHING TURBULENCE OF TEQUENDAMA FALLS: NEAR BOGOTÁ, COLOMBIA

A thunderbolt, according to Chibcha tradition, struck this steep escarpment and made an outlet for a huge lake. Here the small Bogotá River plunges from the Sabana, or Plain of Bogotá, to a depth of 450 feet, its waters narrowing to 40 feet and forming a mass of noisy, brilliant white.



Photograph by Sumner W. Matteson

THE FLEECY VEIL OF UPPER YOSEMITE FALLS

Falls such as this find greatness solely in the height of their descending columns. Though the Yosemite Creek is only 35 feet wide, it makes a vertical drop of more than 1,500 feet in its upper section alone (see text, page 29). At the stream's take-off—"a glorious display of pure wildness"—the heart of John Muir thrilled to the "bright-irised throng of cometlike streamers into which the whole ponderous volume of the fall separates."

The best general view of both falls of Niagara from the top—the finest, fullest panoramic spectacle of descending water in the world—is, so far as my observation goes, enjoyed in a walk from Prospect Point, at the northern edge of the American Fall, along the brink of the cliff to the bridge between New York and Canada, across the bridge, and thence southward along the brink of the Canadian precipice until Horseshoe Fall is reached.

On the American side, at Prospect Point and Hennepin Point and, best of all, between these two points, directly above the elevator to the *Maid of the Mist* landing, are side views of both falls of unsurpassed loveliness (see page 48).

In crossing the bridge to Canada, one stops every few feet to note the changes of loveliness of outline which accompany successive changes in the point of view.

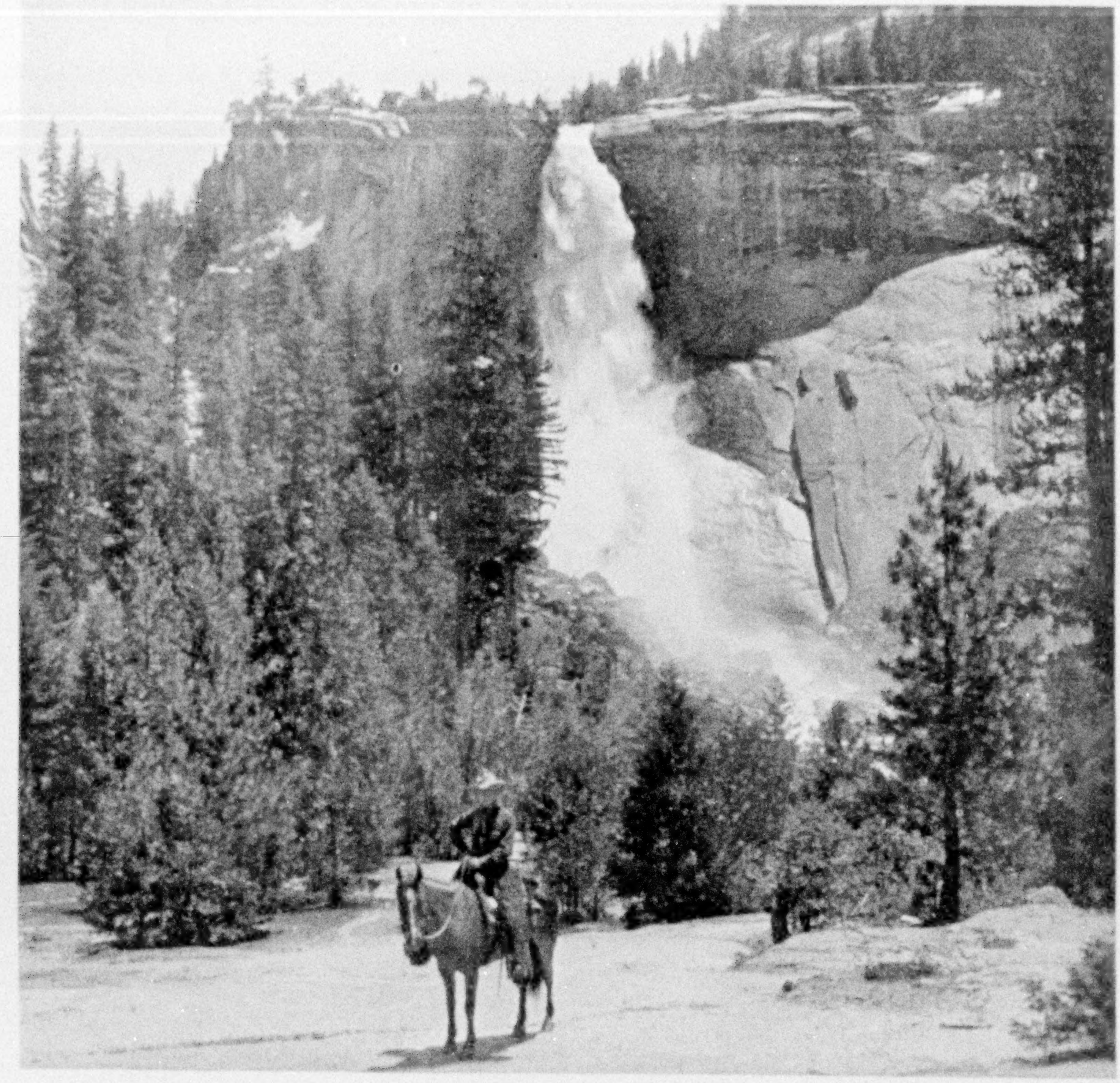
From every lookout on the way, you have both falls at different angles under observation, the successive views vying in picturesqueness and impressiveness.

From the Canadian side the American Fall at first glance seems to present an almost continuous straight front of precipice edge for its full 1,000 feet, but closer examination shows that, outside of its fine north section next to Prospect Point, the face of the precipice recedes by steps and curves, and then curves out again, the same forces (differing in degree, but not in kind) which are making the deep, irregular indentation at the apex of the Horseshoe operating here also, though here the recession due to erosion is only about two inches a year, while at the Horseshoe it is from four to six feet a year.

THE BEAUTY AND MIGHT OF THE HORSESHOE

The effectiveness of the American Fall, in spite of its insignificant volume, is due to skillful exploitation of its available water (see pages 42, 47).

Horseshoe Fall is a thing of beauty as



THE NEVADA IS THE WHITEST OF ALL FALLS IN THE YOSEMITE VALLEY

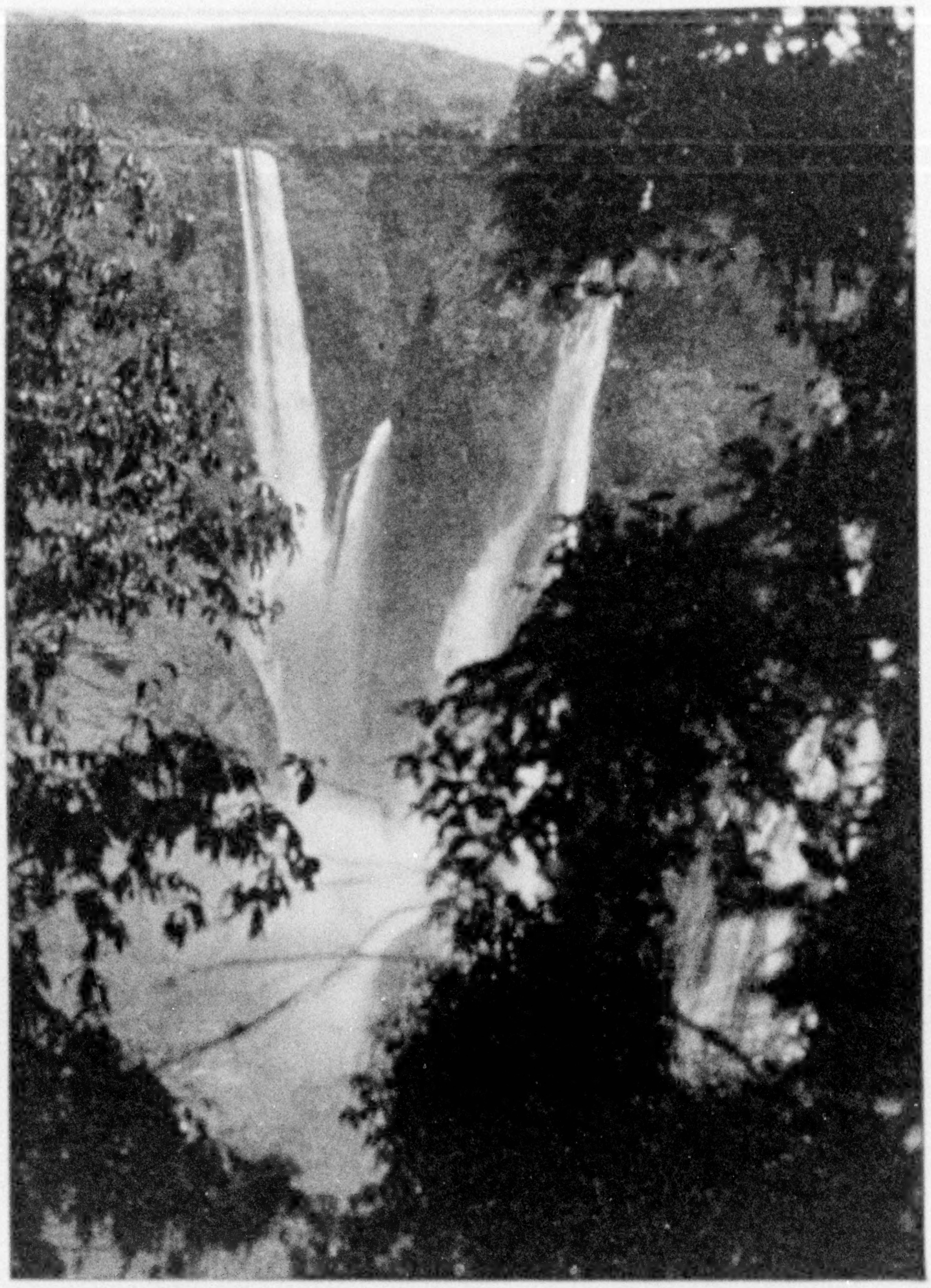
Ranking next in interest to Yosemite Falls, the Nevada writhes for 600 feet down a sharply sloping precipice, on the lower half of which it is pulverized to the finest of spray. Like the Vernal Falls (see page 38), this beautiful cascade is surrounded by rock scenery of novelty and magnificence.

well as power. The eye delights in the fine, irregular inner curve of the horseshoe; in the clouds of light, transparent spray which rise above the fall to varying heights and in diverse shapes, according to climatic conditions and the direction of the wind; in its picturesque environment with Goat Island on one side and Canadian Victoria Park on the other, and in the varied shifting coloring of fall, rapids and spray cloud.

White and cream and lavender show at the shallow edges on both sides of the fall, and light green and dark green, with white and cream fringes and frosting, in the deep columns of descending water in the inside of the horseshoe. The spray cloud displays here a dense, opaque white, and here a transparent, translucent, fleecy whiteness. The bottom of the basin caldron at the foot of the fall shows a deep basic green, almost covered with thick white foam. Its surface from fall to bridge is splotched with the irregular circles of miniature whirlpools.

VICTORIA, THE WONDERFUL

In the heart of Africa, near the borderline between British South Africa and the Belgian Congo, 1,642 miles from Cape Town, on the Cape-to-Cairo Railroad, the waters of the Zambezi River make the



Photograph by E. W. T. Slater

GERSOPPA FALLS, "THE WONDER SPOT" OF SOUTHERN INDIA

From a breadth of 230 feet, the Sharavati River rushes over a cliff 830 feet high in four separate cascades, known as the Raja (or Horseshoe), the Roarer, the Rocket, and La Dame Blanche. The first leaps into a pool 132 feet deep. The third is well named, for the jets of foam into which it shoots burst, rocketlike, into showers of glittering drops. Most beautiful is The White Lady, which streams over a rock wall in lacy cascades. A rainbow spans the waters during the afternoon, and on a dark night a weird glare is made by casting rockets, torches, or burning straw over the cliff.

wonderful descent which David Livingstone, the first white man to see the fall, named Victoria in honor of England's Queen.

As the Zambezi, grown great in its hundreds of miles of journeying from its source, majestically moves seaward with the lazy dignity that is becoming to a mile-wide tropical river, it is suddenly, without warning, hurled over and dashed to the bottom of a deep, narrow chasm, cleft at right angles to its course; and at the foot of the abyss its forward flow is checked by a basaltic precipice, which forms the opposite wall of this chasm (see pictorial diagram, page 50).

The mass of falling water, disintegrating in air, shattered by collision with the rocky bottom and in flood with the opposing cliff, is driven backward and upward in clouds of spray, rising hundreds of feet in air in ever-changing forms.

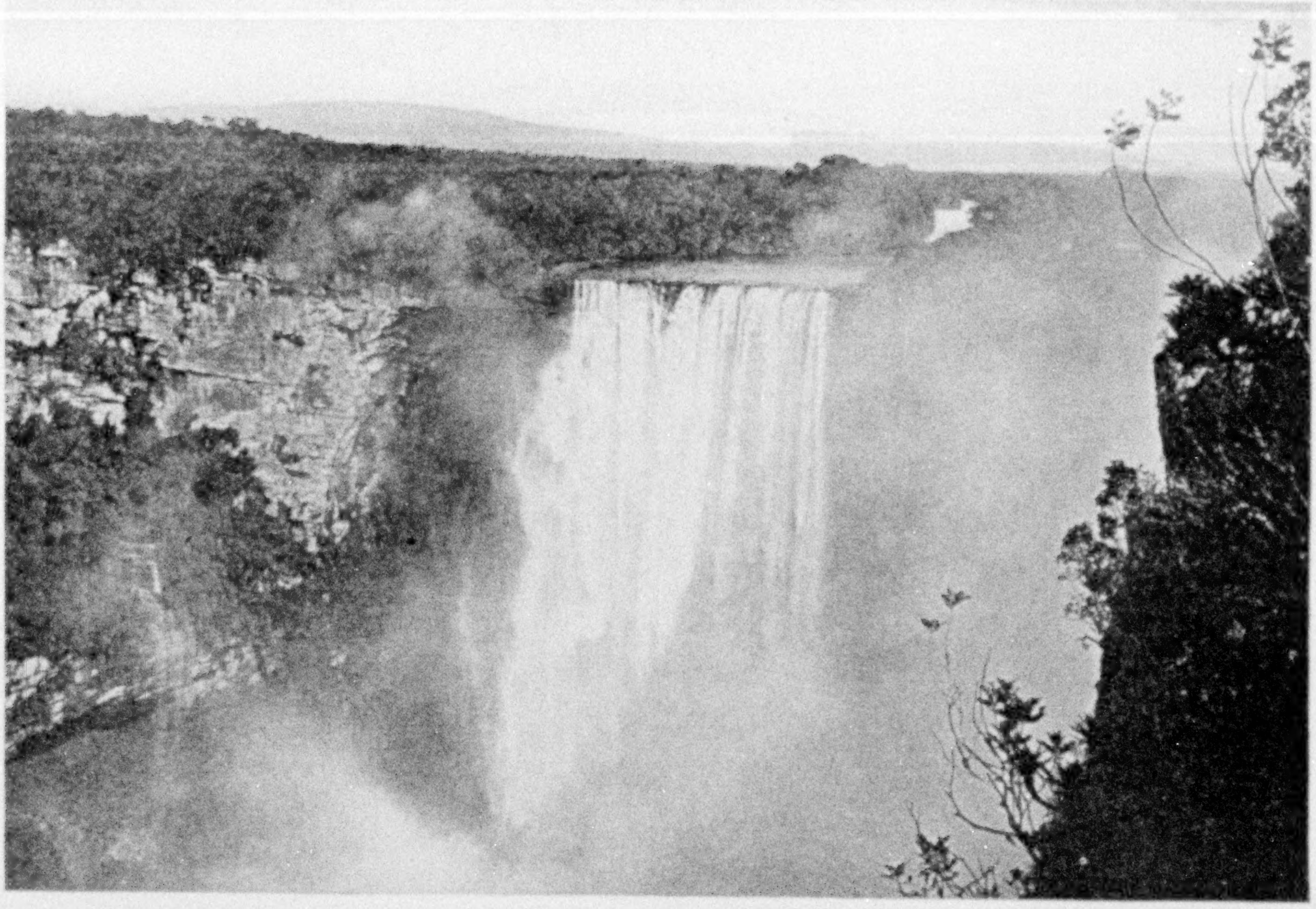
Out of the whirling spray the rudely assaulted river thunders its startled indignation. The sound of its protest can be heard, and the river, rising in air in spray-clouds like the smoke of a vast fire, can be seen for many miles.

This is *Mosi-oa-Tunya*, "the smoke that thunders," as the natives poetically and aptly named the falls now known as Victoria.

THE GREAT DISAPPEARANCE

Never was there transformation more extraordinary than that here suffered by the Zambezi. The mile-wide, comparatively shallow, river is, in the twinkling of an eye, turned edgewise into a cleft in the earth's surface with a breadth between imprisoning walls of stone of 200 to 300 feet and of unknown depth.

From moving slowly and steadily in one direction, its waters—shocked, battered, disintegrated—fly and flow with



Photograph by Dr. Henry E. Crampton

AN OBSCURE AND ISOLATED WONDER OF THE WORLD: KAIETEUR, BRITISH GUIANA

The smooth, but rapid, Potaro River, 400 feet wide, "flows quietly to the brink and turns quietly downward," breaking into soft white mist during its fall and reaching the bottom in a chaos of seething clouds. The water tumbles perpendicularly for the first 741 feet, then slopes as a cataract to a still reach below. The entire drop of 800 feet would make almost five Niagaras. When the day wanes, swallows return to the chasm for their night's rest in the cavern behind the falls.

incredible velocity in every direction. They mount high in air in spray, and, condensing, descend again and are caught once more in the rising current of wind and water. They rush wildly from each end of the falls canyon, where the abyss is shallowest, toward the middle, both deep and narrow currents seeking escape from the cramping, imprisoning walls of the opposing precipices of basalt.

The two sections meet and find this vent about three-fourths of the distance from the western to the eastern end of the chasm, where the raging waters force themselves through another deep crack in the earth's surface even narrower than the falls canyon itself.

Down this narrow opening, at right angles to the falls chasm, the reunited waters of the Zambezi rush as rapids with tremendous power, and almost immediately dash full front against another precipice of basalt, and are thrown back on themselves in furious, boiling whirlpool.

Thus diverted from its course, the raging torrent shoots off almost at right angles through another narrow gorge approximately paralleling the falls chasm and nearly reversing its direction of flow in that chasm (see page 52).

When the river is about on a level on this course with the west end of the falls canyon it doubles back upon itself at an acute angle, and when almost on a level with the east end of the falls chasm it repeats this zigzag process, with the result that the Zambezi's course through the falls canyon and the three immediately succeeding gorges lays out a great M, cut into the earth's crust 400 feet deep, plus the depth of the Zambezi's channel in the canyon.

A FALLEN, DEGENERATE, WORTHLESS ZAMBEZI

Its fall not only thus alters the Zambezi's physical appearance, but transforms it from a benefactor bestowing blessings into a worthless, wandering tramp.

Above the falls the Zambezi irrigates a great area, giving life, freshness, and fertility to its valley and its islands, clothing them with towering palms and with infinite variety of form and color of luxuriant tropical vegetation, and rendering them fruitfully responsive to the hand of man. After the fall the Zambezi's waters are buried 400 feet below the dwellers on the earth's surface, and outside the radius of the river's spray that surface is arid. For 45 miles of this low life in the canyon the fallen river is self-concentrated and useless.

The extraordinary conformation of the Zambezi gorge, while it compels inspection from its very edge to comprehend it, permits this close examination and repays him who makes it with a series of intimate and wonderful views of falls and chasm and gorge, of water and rock, torrent and whirlpool, and of towering precipices of basalt.

The great wall of rock, extended in front of the falling river like a huge dam across its entire width, with its summit on the same level as the surface river, and pushed within 250 feet of the descending waters, shuts out any general view of the face of the mile-wide series of falls, such as is enjoyed of Niagara from the Canadian side; but it compensates by furnishing along its very edge a series of frontal and side views—close, intimate, and thrilling—of the various sections of the falls.

For four-fifths of the distance from the west end of the falls canyon to the outlet gorge the edge of the canyon is crested with trees, including tall and graceful date palms, ferns, and tropical undergrowth, which, frequently and in places constantly bathed in spray rising from the falls chasm, are appropriately called the Rain Forest.

At some points the Rain Forest creeps, with dripping vegetation and fallen tree trunks, to the very verge of the precipice. In other places wet and slippery rocks substitute themselves for vegetation at the edge of the chasm. A hard, well-made footpath traverses the forest, paralleling the falls canyon and only a short distance from it, and frequent branches lead from this main footpath to those points at the edge of the precipice from which especially fine views may be obtained. For most of the way one may follow the precipice edge and disregard the path, if the wind and spray permit.

In any event, a visit to the Rain Forest means sopping feet and probably a drenching to the skin, in spite of waterproofs and umbrellas; but in some conditions of wind and spray no glimpse whatever of the falls can be had from many fine viewpoints.

SPECTACULAR VIEWS FROM RAIN FOREST

From the chasm's west end one looks down upon Devil's Cataract and visions in front the spray-filled abyss, with the precipice of Cataract Island and a section of Main Fall on the left, and the black precipice, crowned by the Rain Forest, on the right (page 49).

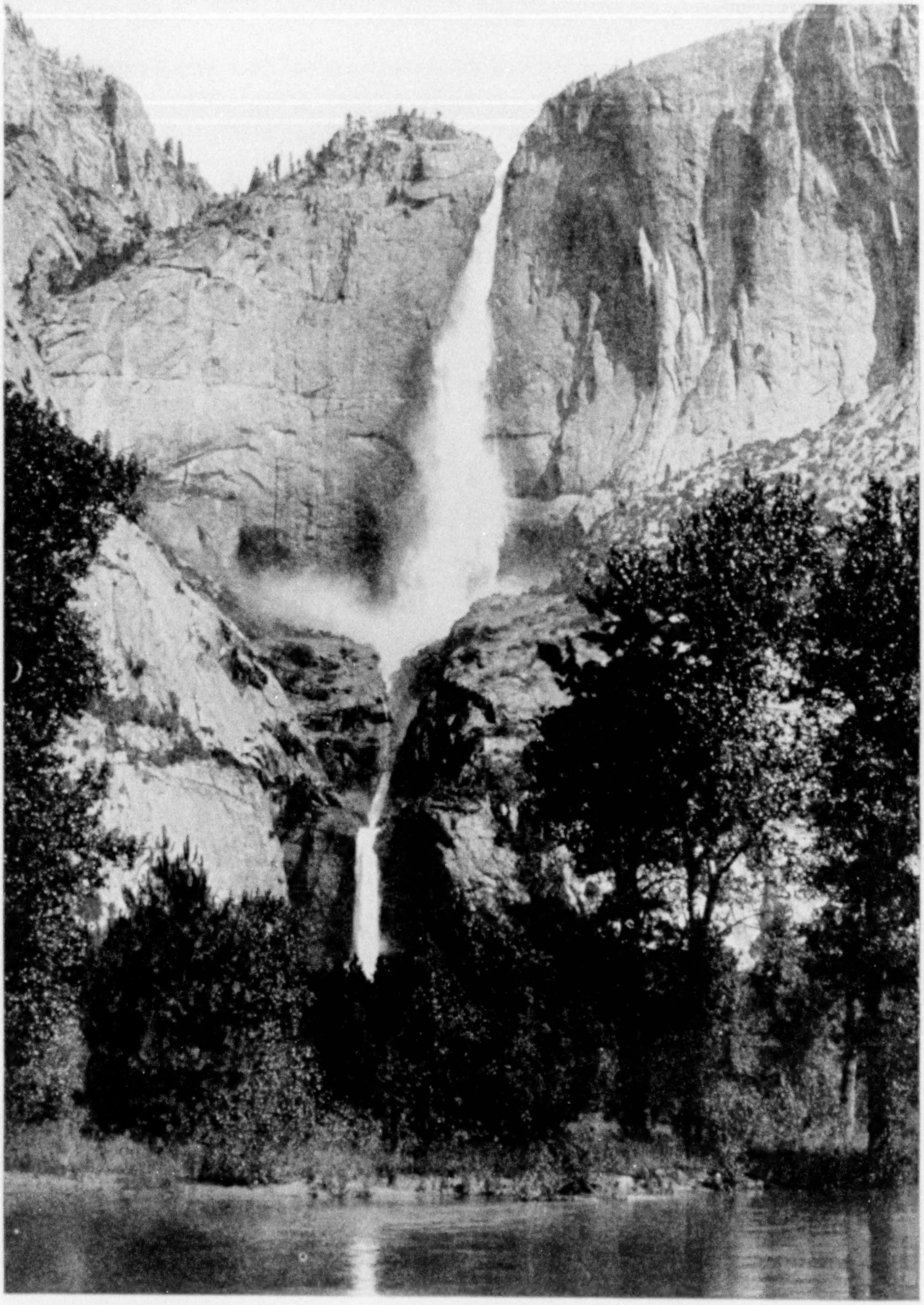
Devil's Cataract, in contrast with the languid glide of most other sections of Zambezi above the Falls, rushes in rapids foaming to the precipice's edge and leaps far out into the chasm, its waters seeming to break suddenly into millions of white particles, sparkling like diamonds in the sunlight.

The most striking Victoria view is of Main Fall from the Rain Forest, a half-mile sheet of foaming white and green. It sends over a greater volume of water, it thunders louder, it shoots a higher cloud of spray into the sky than any other part of the falling Zambezi (page 44).

Next in interest is the beautiful and impressive spectacle of the hundred cascades of picturesque Rainbow Falls. Here the canyon is deepest and narrowest, and from this point one can lean over the precipice edge and look straight down to the bottom of the chasm (page 51).

IN FLOOD, WHEN BEST WORTH SEEING, VICTORIA IS INVISIBLE

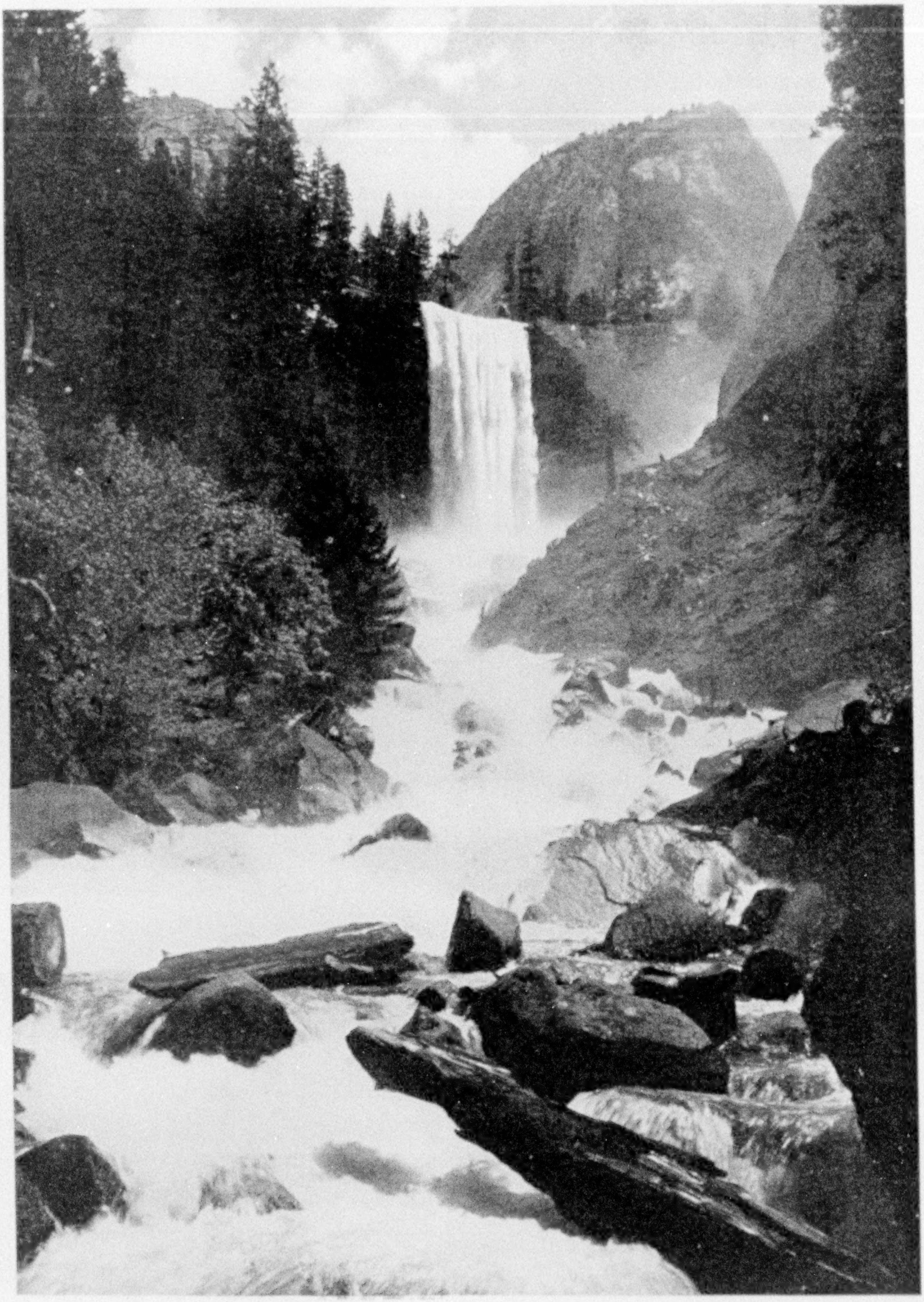
Victoria Falls, with the Zambezi in flood, impress the observer more deeply with the sense of tremendous power than when the water is low, but to counterbalance this advantage is the loss at flood time of most of the opportunities to see the falls and canyon at all. The spray, which at low water mildly drenches the visitor to the Rain Forest, at flood season buffets and blinds him, and drives him away dissatisfied. The whole of the falls chasm is then so filled with dense spray, driven by furious gusts of wind,



Photograph by Pillsbury Picture Co.

THE BREATH-TAKING LEAP OF YOSEMITE FALLS

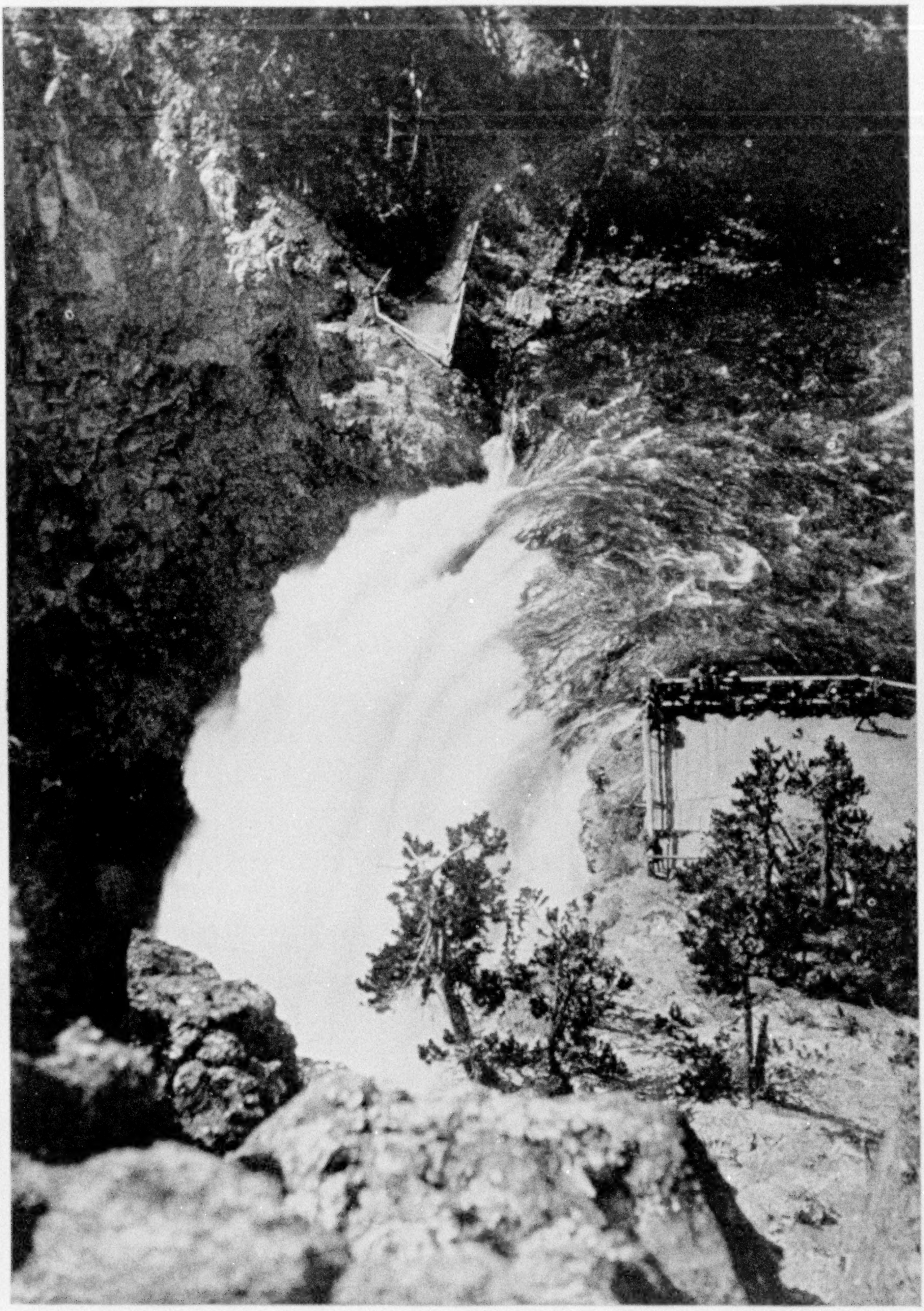
In that unparalleled "realm of falling water," Yosemite National Park, the highest cataract in the world plunges 2,600 feet to the floor of the valley. Its triple cascades present a wavering, broken, silver ribbon, often edged with rainbows and standing out in vivid relief against the red and yellow granite of the background (see, also, page 32).



Photograph by Pillsbury Picture Co.

VERNAL FALLS—"STAID, ORDERLY, GRACEFUL, EASY-GOING": YOSEMITE VALLEY

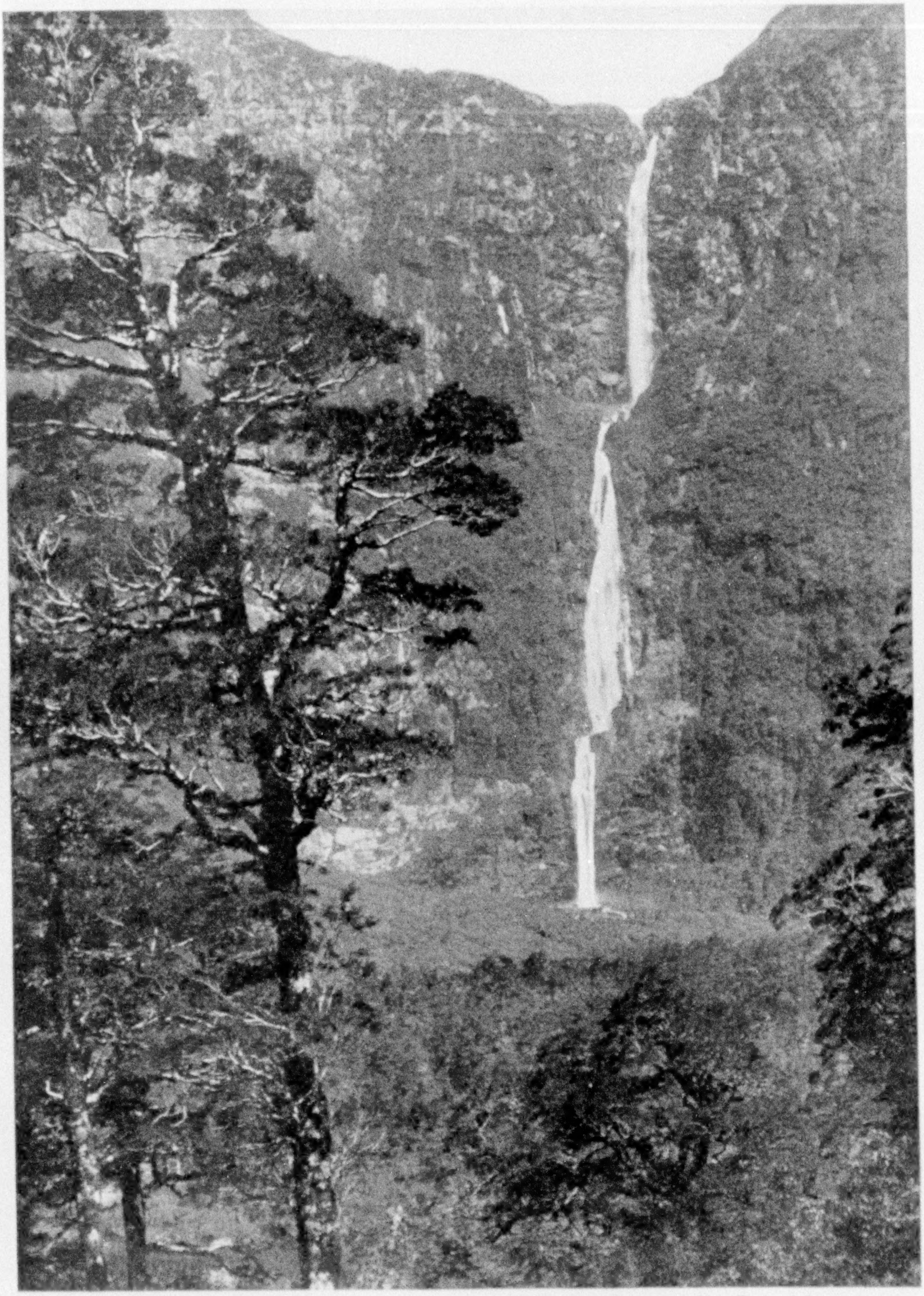
This 400-foot cataract is noted for its afternoon rainbows. Its waters flow calmly over the precipice edge in a sheet 80 feet wide, which changes in color from green to purplish gray and white in its descent to the bowlders. From under the broad spray clouds the unspent river starts anew on its adventure down the wild canyon.



Photograph by Charles Martensen

THE "TAKE-OFF": GREAT FALLS OF THE YELLOWSTONE

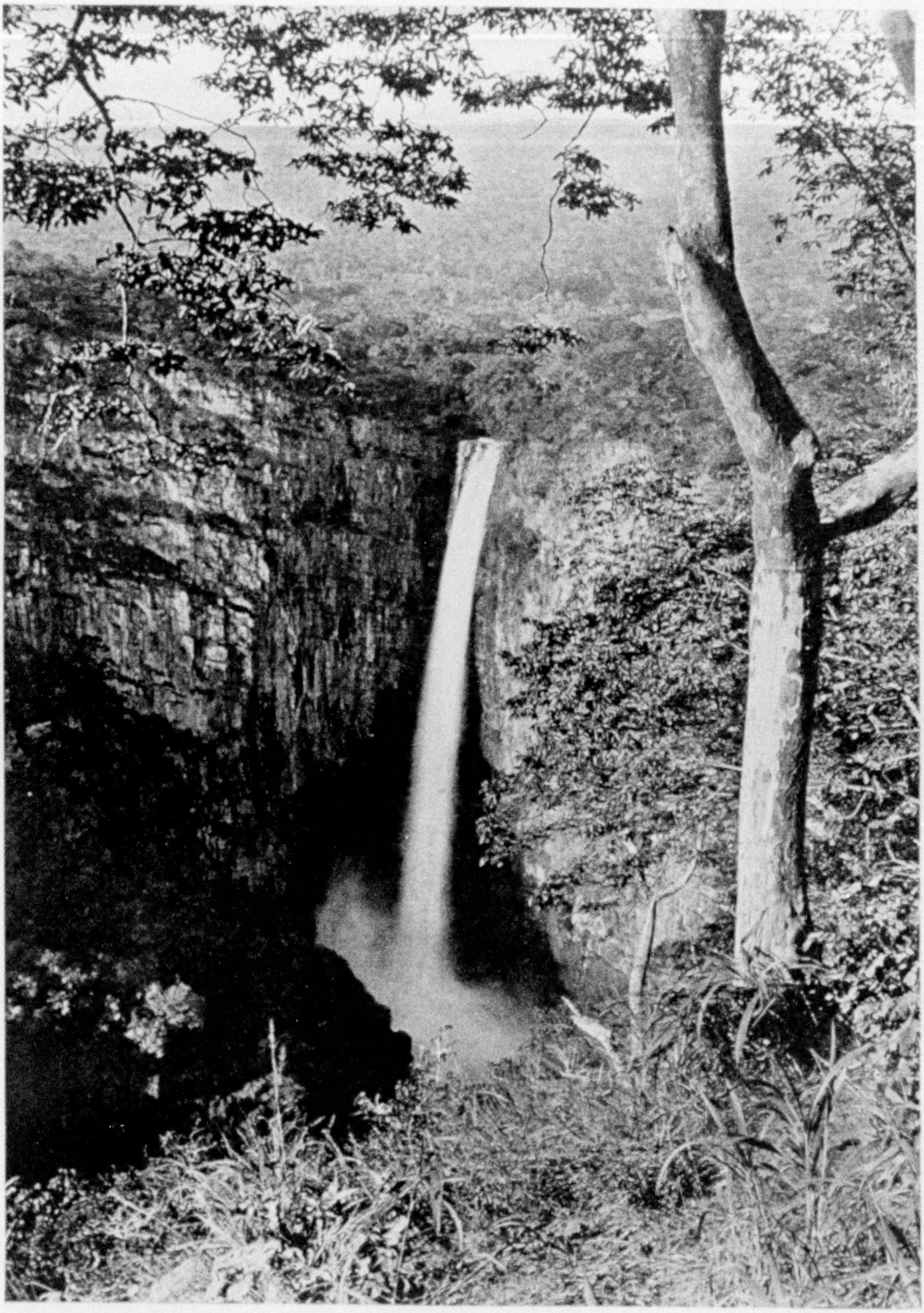
The photograph was taken from an outjutting point of rock about 200 feet above the fall's crest, from which the water makes an almost perpendicular drop to the river—"a finger-wide strip of jade green." Below the fall the Yellowstone enters the Grand Canyon, which, though 20 miles in length, displays its most marvelous coloring for the first three miles.



Photograph courtesy New Zealand Government

SUTHERLAND FALLS, THE YOSEMITE OF NEW ZEALAND

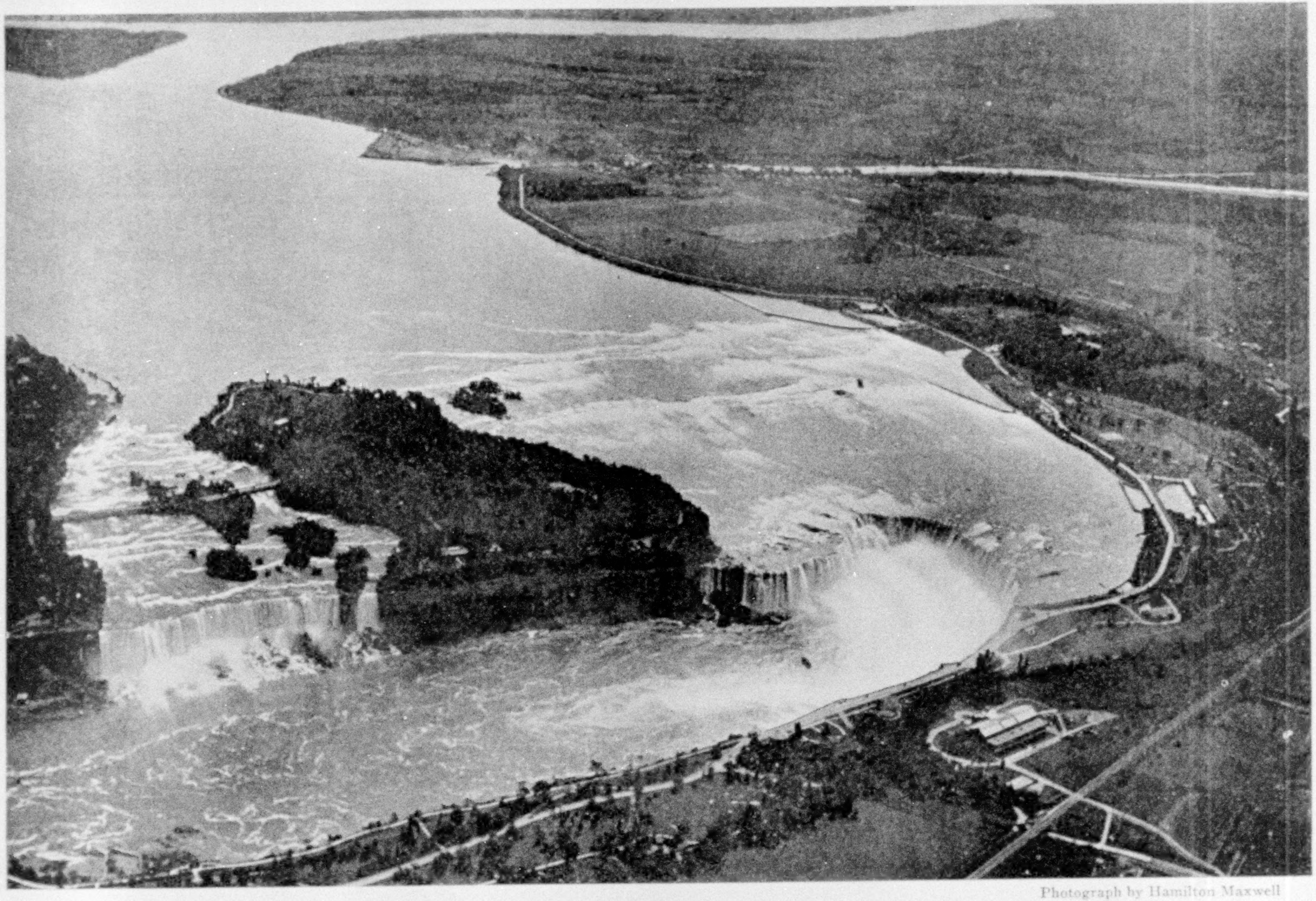
This slender, silvery thread of the Arthur River divides into three sections, with lengths of 815, 751, and 338 feet, thus falling a total length of 1,904 feet. Comparatively few individuals have seen this exquisite gem, for it lies off the beaten track, 16 miles from the head of Milford Sound, a fiord on the southwestern coast of South Island. The falls bear the name of the prospector who found them in 1879.



Photograph by James Scott-Brown

AN AFRICAN BEAUTY IGNORED BY MAPS: KALAMBO FALLS

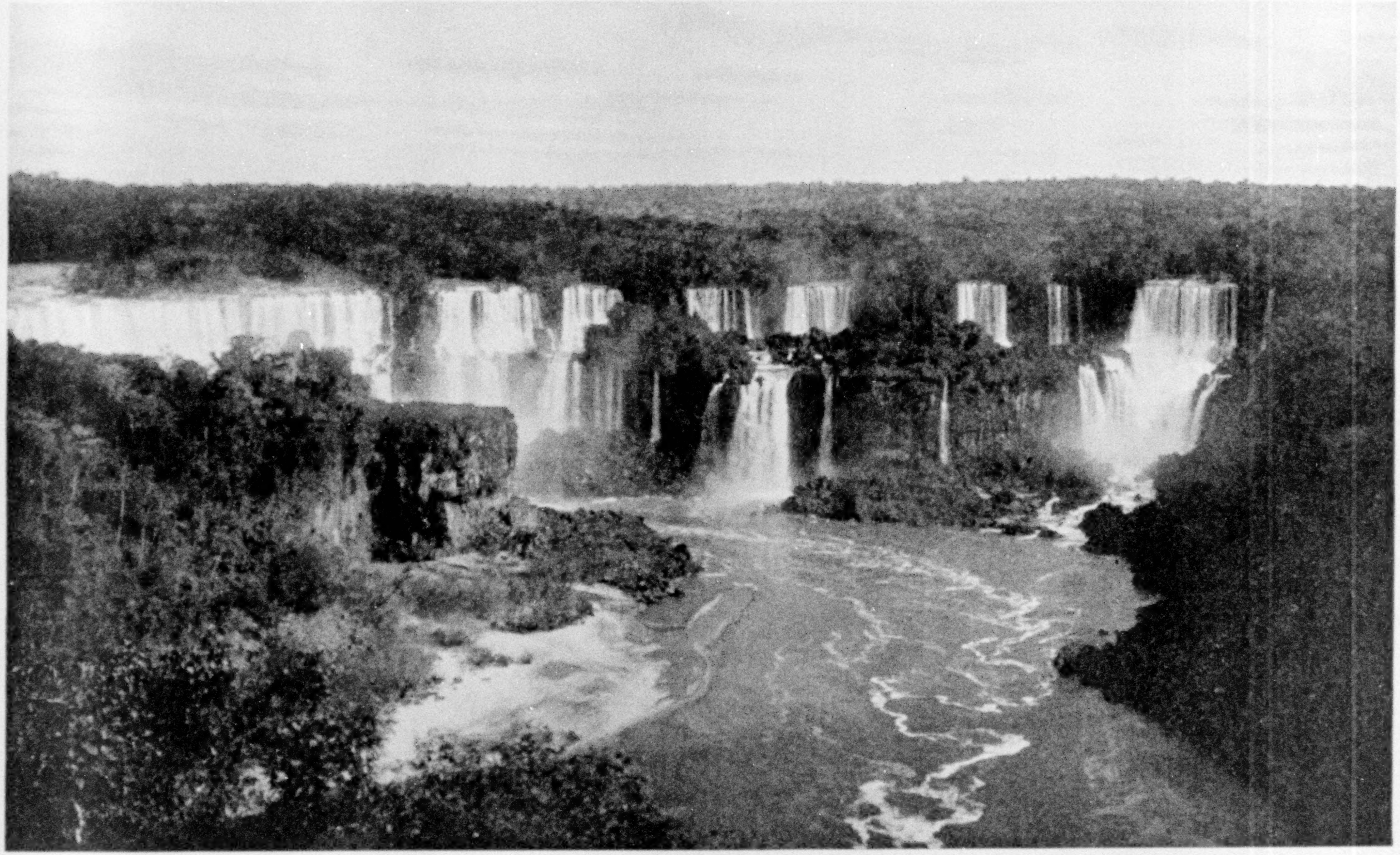
Though the river of this name forms the boundary between northern Rhodesia and Tanganyika Territory, its remarkable falls were apparently not discovered until recent years, in the course of the British Cape-to-Cairo Motor Expedition. Their existence was revealed by this photograph and a diary found in the effects of one of the explorers, now deceased. The torrent plunges over a precipice, making first a sheer drop of 1,200 feet, then a second of 200 feet.



Photograph by Hamilton Maxwell

MATCHLESS NIAGARA FROM THE AIR

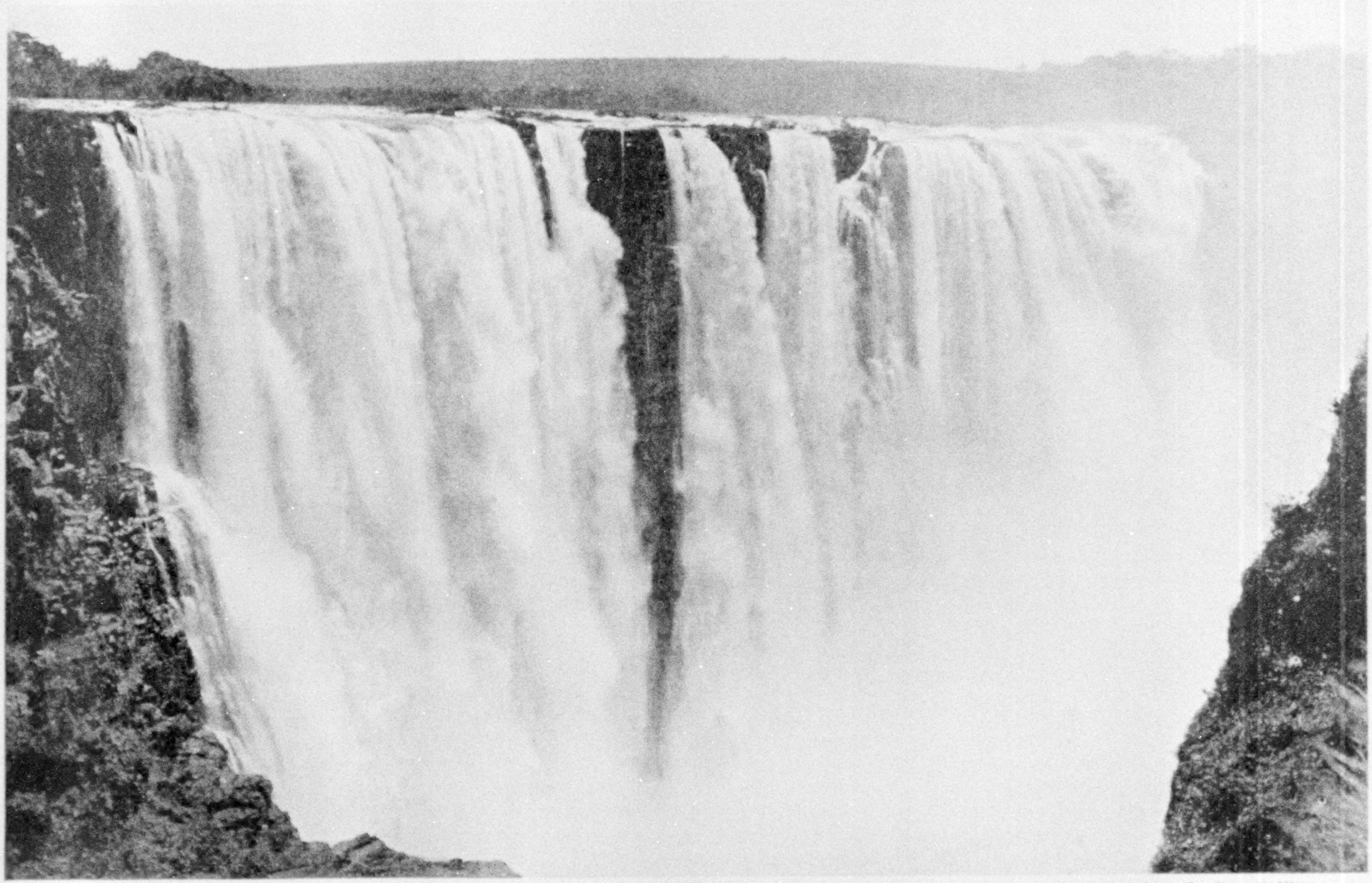
Into the basins of the four Great Lakes which form the source of Father Hennepin's "vast and prodigious cadence of water" pours half the fresh water of the world. Niagara surpasses Victoria and Iguazu in volume, in visibility and accessibility for general and detailed study, while its winter ice gorge (see, also, page 47) displays its unique and fantastic forms of icicles and frozen spray. The beauty of the American Fall (left) arises from a comparatively unbroken 1,000-foot crestline, with evenly distributed waters, while that of the Canadian Fall (right) lies in the variety of shape and shifting gamut of color of the bank of spray and foam hiding its huge volume.



Photograph from Theodore W. Noyes

THE SPECTACULAR SAN MARTÍN SEMICIRCLE OF IGUAZU

The most comprehensive single view of this section of the falls is from the Brazilian side. To the right is Bossetti, one of the finest of Iguazu's minor falls; at the left is the top of the principal San Martin Fall, seen over San Martin's Island; San Martin Rapids in the center. Though Iguazu lacks the power and volume of Niagara, its exquisite tropical setting displays its diversity and beauty to greater advantage (see, also, pictorial diagram, page 57, and illustrations, pages 56 and 59).



Photograph from Gardiner F. Williams

THE MAIN FALL OF VICTORIA FALLS FROM THE BEGINNING OF THE RAIN FOREST

This view is from the west end of the chasm, with the edge of Cataract Island at the left and the edge of Rain Forest precipice at the right. There is no more magnificent spectacle in the world than this (the spray permitting) of the Main Fall's half-mile sheet of water descending 360 feet. The Main Fall sends over a greater volume of water, it thunders louder, and it shoots a higher cloud of spray into the sky than any other part of the falling Zambezi.

that observation and study become practically impossible.

At that time one cannot cross the rapids above the falls to Livingstone Island, which at the verge of the precipice separates the Main Fall from Rainbow Falls, much as Goat Island separates the American and Horseshoe Falls of Niagara. From this island Livingstone caught his first glimpse of the falls, and to the visitor in the dry season it affords one of the most interesting and striking of viewpoints.

On the western edge of Livingstone Island one can lean over the precipice and get a fine view of the eastern section of the Main Fall, which projects a white mass well out into the chasm, and under which, at some time in the future, processions of waterproofed tourists may be expected to grope gaspingly, as in the Niagara Cave of the Winds.

As a whole, the precipice wall opposite the falls is as impressive as that over which the Zambezi descends. It displays vast masses of towering dark-brown rock, here dampened into deep blackness, here green and yellow in patches with lichen and moss, crowned with the vivid green and graceful outlines of the Rain Forest and clothed in the shimmering whiteness of sunlit rainbow-circled clouds of spray.

IGUAZU, THE PICTURESQUE

In the heart of South America, where Brazil and Argentina come together, with Paraguay close at hand, the Iguazu River leaps from the great Brazilian central plateau over a precipice nearly half as high again as that of Niagara.

In falling it distributes its waters in two main falls, and at low water a hundred cataracts, over an area more than twice as great as that of the falling Niagara, including Goat Island.

With its source in the Brazilian coast mountains, only 30 miles from the Atlantic Ocean, the Iguazu traverses westward the Brazilian central plateau for 430 miles before it plunges in cataract over the plateau's precipitous edge.

Most of the great rivers of South America have descended from this plateau and flowed to the sea either through the Amazon or La Plata; but the descent of the Iguazu is the most spectacular of all (see pictorial diagram, page 57).

The Iguazu above the falls, with the stream at low water a half mile wide, glides lazily toward the edge of the precipitous plateau, but before descending, it broadens and shallows, and so widely distributes its waters that its half-mile width is more than doubled when it falls over the precipice; and it spreads thinly and interruptedly over two miles of contour sweep, if intersecting islands are included in the measurements.

A few miles above the falls, while the river is still in Brazil, the Iguazu makes a sharp bend, and, as it nears the precipice edge and the Argentina boundary line, it divides into two currents; one, much the deeper, hugs the Brazilian bank and rushes into the end of a deep, narrow canyon, one side of which is Brazilian and the other Argentine.

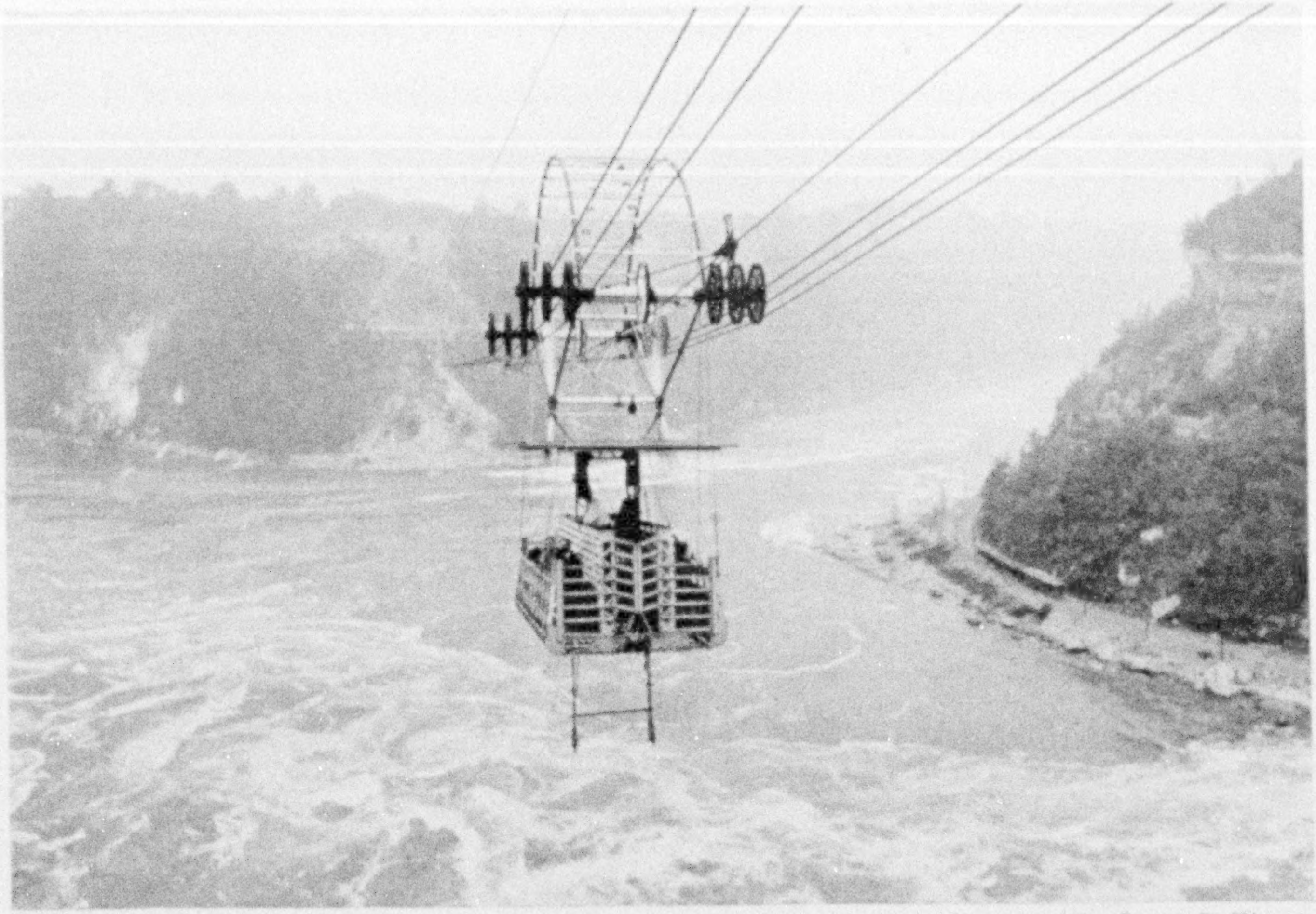
The other current, and the rest of the volume of the river, rushes in a vast, irregular semicircle on the Argentine plateau, among rocks and islets, before leaping from its precipice, in one main fall and in innumerable cataracts, in two drops, to the bottom of the canyon.

Midstream from the lip of the falls precipice a large island (San Martin), corresponding to Goat Island at Niagara and Livingstone and Cataract islands at Victoria Falls, projects in long, peninsular shape, descending gradually to the river level below the falls. This island, separating the two channels, is heavily wooded, so that each section of the falls is hidden from the other, and except from an airplane one cannot at the same time fully see both.

The deep, narrow canyon down which the bulk of the Iguazu's volume rushes is called Devil's Throat. The wide, semicircular sweep of the rest of the descending waters is called San Martin Falls.

The water from Devil's Throat Chasm rages downward on one side of San Martín Island, and that from the San Martín Falls down the other. The two floods come together at the point of San Martín Island, and the reunited Iguazu rushes in deep, narrow rapids to its junction with the Paraná River, 12 miles below.

On top of a precipitous eminence, facing the San Martín section of the Iguazu, is the Argentine Hotel. On top of a still higher hill on the Brazilian side of the river is the unfinished Brazilian Hotel.



Photograph by George R. King

A MECHANICAL BLONDIN OVER WHIRLPOOL RAPIDS: NIAGARA FALLS

Some idea of the sensations of the tightrope walkers who have crossed the gorge on ropes of wire may be gained from a ride in this 1,708-feet-long aërial tramway. An immense volume of water is forced at this point to flow through a channel less than 300 feet wide. At the Whirlpool the river bends suddenly at right angles, throwing the full force of its current against the left bank and forming a maelstrom 1,150 feet wide.

Between the two flows, in rapids below the falls, the reunited Iguazu, hidden from sight in the dense forest.

SCENIC VIEWPOINTS OF IGUAZU

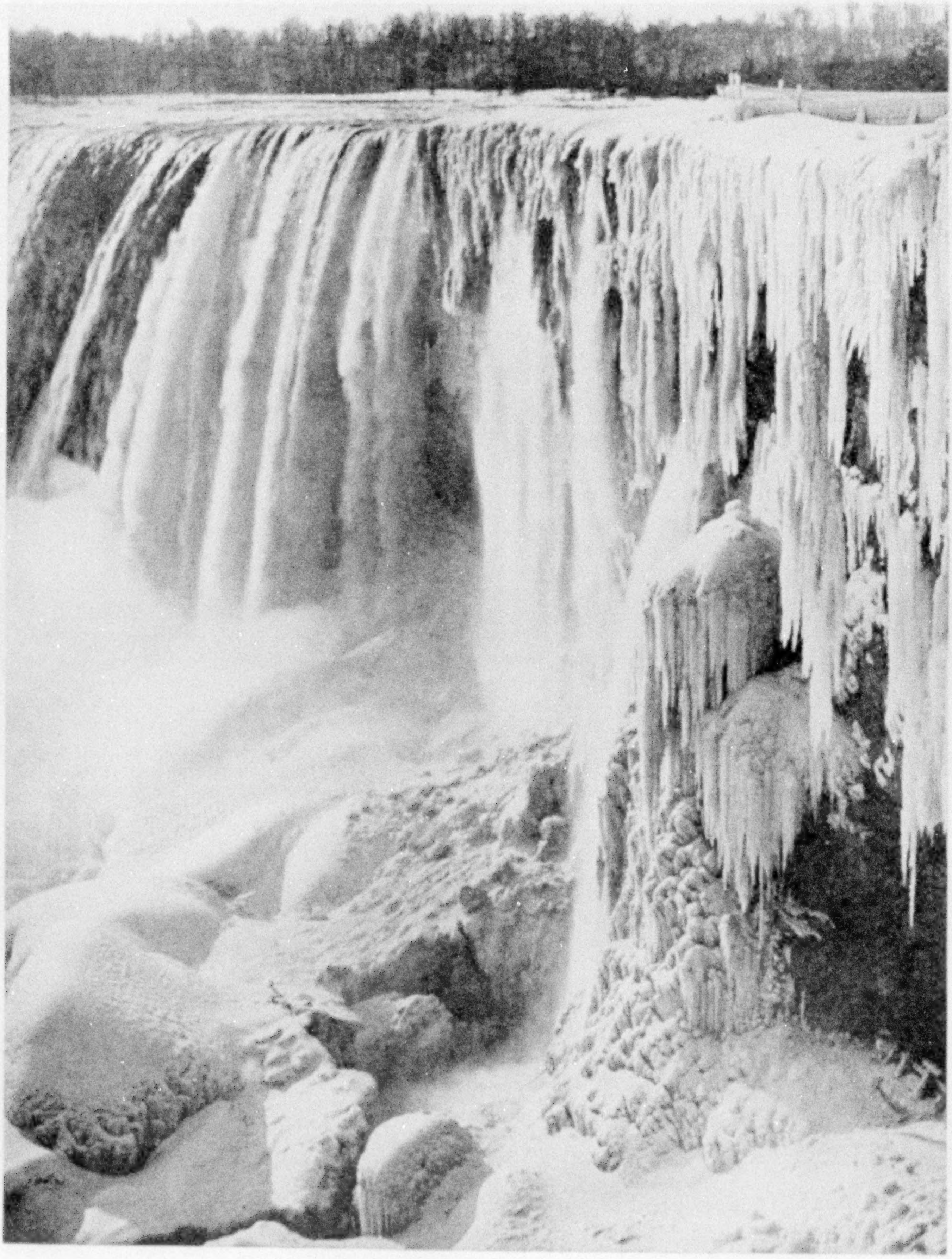
The finest accessible views are: (1) From the Argentine Hotel hillside; (2) Of the Devil's Throat Chasm and Union Fall from the edge of the falls precipice in Argentina, and (3) From the Brazilian side of the Iguazu.

The hillside view of the semicircular sweep of San Martín, with a continuation including San Martín Island, the rapids of both San Martín and Devil's Throat, and over the green of San Martín Island the white band of the top of Union Fall and the cloud spray rising above it from Devil's Throat furnish the only approach to a comprehensive panoramic view of Iguazu Falls that is possible, (see page 56).

A striking view of San Martín is enjoyed from the side of Bossetti Cataract. Palms and bamboos and trees with parasitic orchids constitute the environment of Bossetti. We enjoyed here sight of the first of the artistic settings of green, varied by cream and flame-colored flowers, which frame the white of the descending waters of so many of Iguazu's cataracts.

From this viewpoint one sees to best advantage the great main fall of San Martín, second in volume only to Union Fall in Devil's Throat, which here descends in broad impressive mass. San Martín makes two leaps, each over one hundred feet in height, but the intervening rocky platform upon which the upper fall descends is so narrow and so shrouded in spray and mist that the effect from this viewpoint is of one great fall, foaming and raging with increasing intensity as it descends (see page 59).

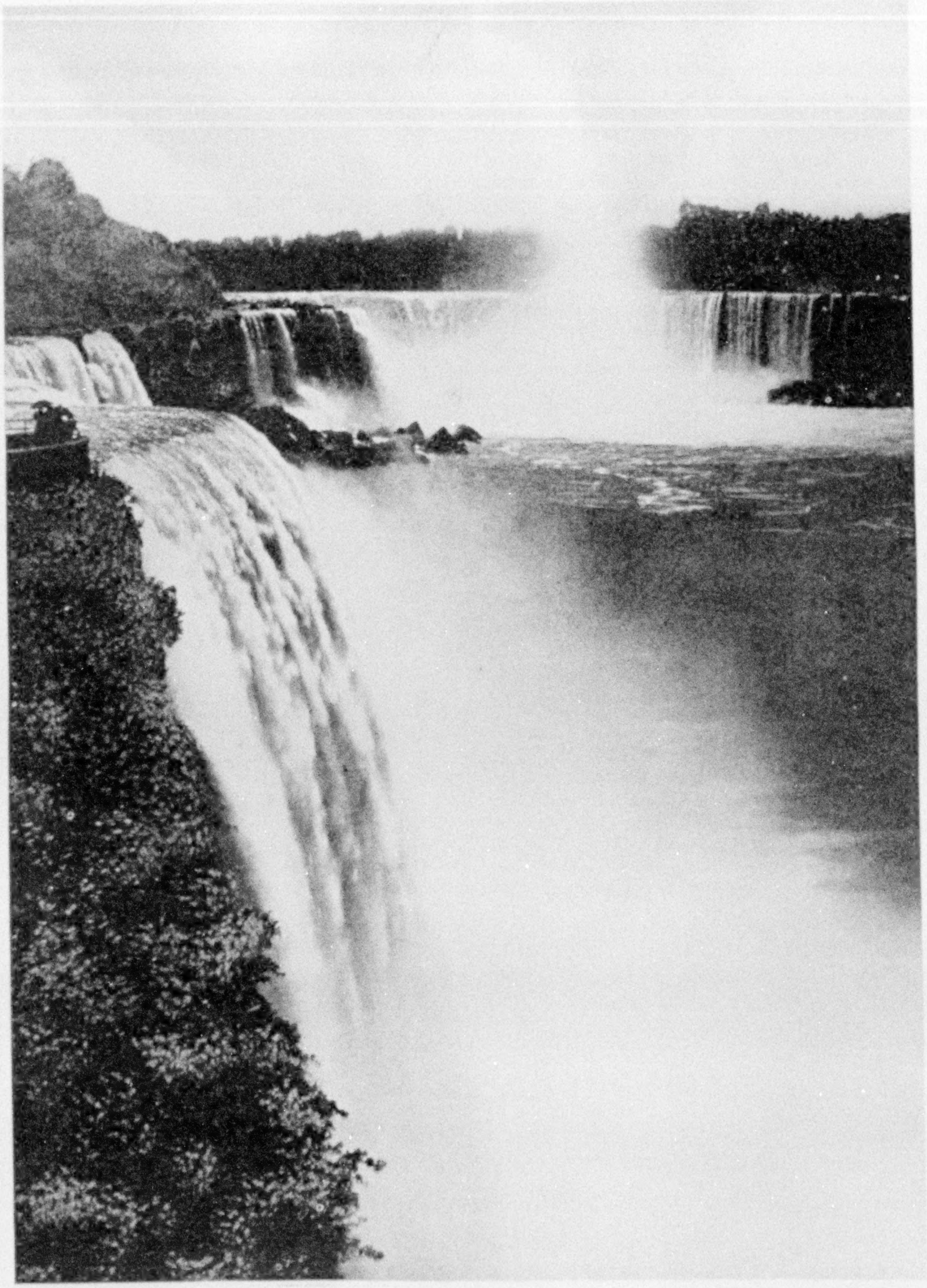
From this hillside glimpses are also obtained up the Devil's Throat, with the Brazilian Falls on the left and the spray cloud of Union Fall filling the end of the chasm (see page 58).



Photograph by Ernest Fox

THE HORSESHOE (CANADIAN) FALL OF NIAGARA IN WINTER GARB

In the unadorned loveliness of summer, this giant hides itself more and more by erosion within a narrow cleft of the precipice, and further conceals itself behind a curtain of opaque white spray. In winter its form is clothed with icy lacework and embroidery, which enhance its allurement without destroying its grandeur and impression of vast power (see text, page 32).



Photograph by Ernest Fox

WHAT FATHER HENNEPIN SAW

The finest panoramic spectacle of Niagara is obtained from Hennepin Point—the first view of the Falls seen and described by a white man, Father Hennepin, in 1678. Here the American Fall (left), Niagara's highest drop, churns its torrent to a roaring mass of whiteness, its precipice face terminating in the fine, small fall between Luna and Goat islands. Beyond it is the tree-crowned face of Goat Island Cliff. The projecting heel of the American side of the Horseshoe Fall hurls its broken, fleecy cataracts from shelf to shelf, then leads the eye to the latter's inner section, obscured in the center by shifting clouds and columns of white spray.

Photograph from Gardiner F. Williams

VICTORIA FALLS CHASM FROM DEVIL'S CATARACT

A section of the chasm from its west end. To the left Devil's Cataract descends, shooting out into the chasm. Then appears the precipitous, deeply indented face of Cataract (or Boaruka) Island. Next a view down the falls chasm with a glimpse of the Main Fall disappearing in spray clouds. At the bottom of the canyon the water rushes away from the observer. To the right looms the precipice opposite to the Fall, crowned by the Rain Forest.

The most intimate and impressive view of the greatest of the Iguazu falls is from an islet on the lip of the precipice on the Argentine side, near where Rivadavia cataract dashes over the precipice into Devil's Throat.

On our way by boat, at low water, to Devil's Throat we are landed on two small islands, which we traverse by paths cut through underbrush or passing over short bridges. We finally find ourselves on a projecting islet, face to face with Union Fall, across a narrow chasm, looking down into Devil's Throat, with Rivadavia rushing over the precipice at our very feet.

Beyond Rivadavia cataract begins the broad, curving, continuous band of Union Fall, commencing with a straight-faced, narrow, very high fall, which makes a single leap to the foot of the precipice, its waters overlapping and merging with the rest of Union Fall, which, through a slight erosion at the very edge of the precipice, drops a few feet to an invisible platform before making its single plunge of more than 200 feet to the bottom of the chasm (see pages 54 and 59).

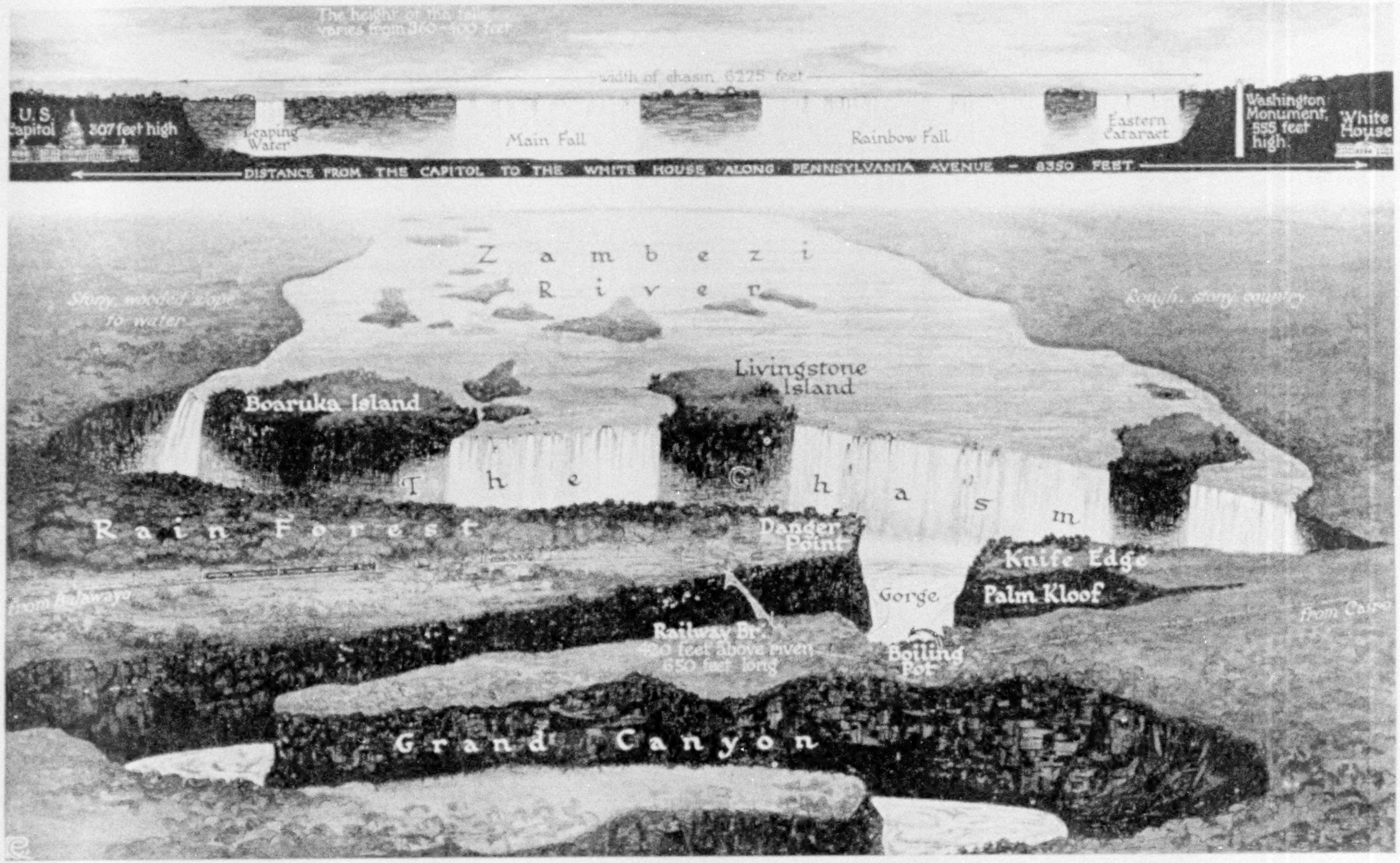
Myriads of swallows dart to and fro in the spray cloud and rainbows of brilliant coloring are almost always visible.

From this viewpoint are seen to best advantage all of the Brazilian falls, including a series of beautiful unnamed cataracts and impressive Floriano.

SPECTACULAR VIEWS FROM BRAZIL

Formerly the difficulties and time-wasting obstacles in the way of seeing the falls from both the Argentine and the Brazilian sides in the same visit were so great that hardly any of the earlier visitors enjoyed both viewpoints.

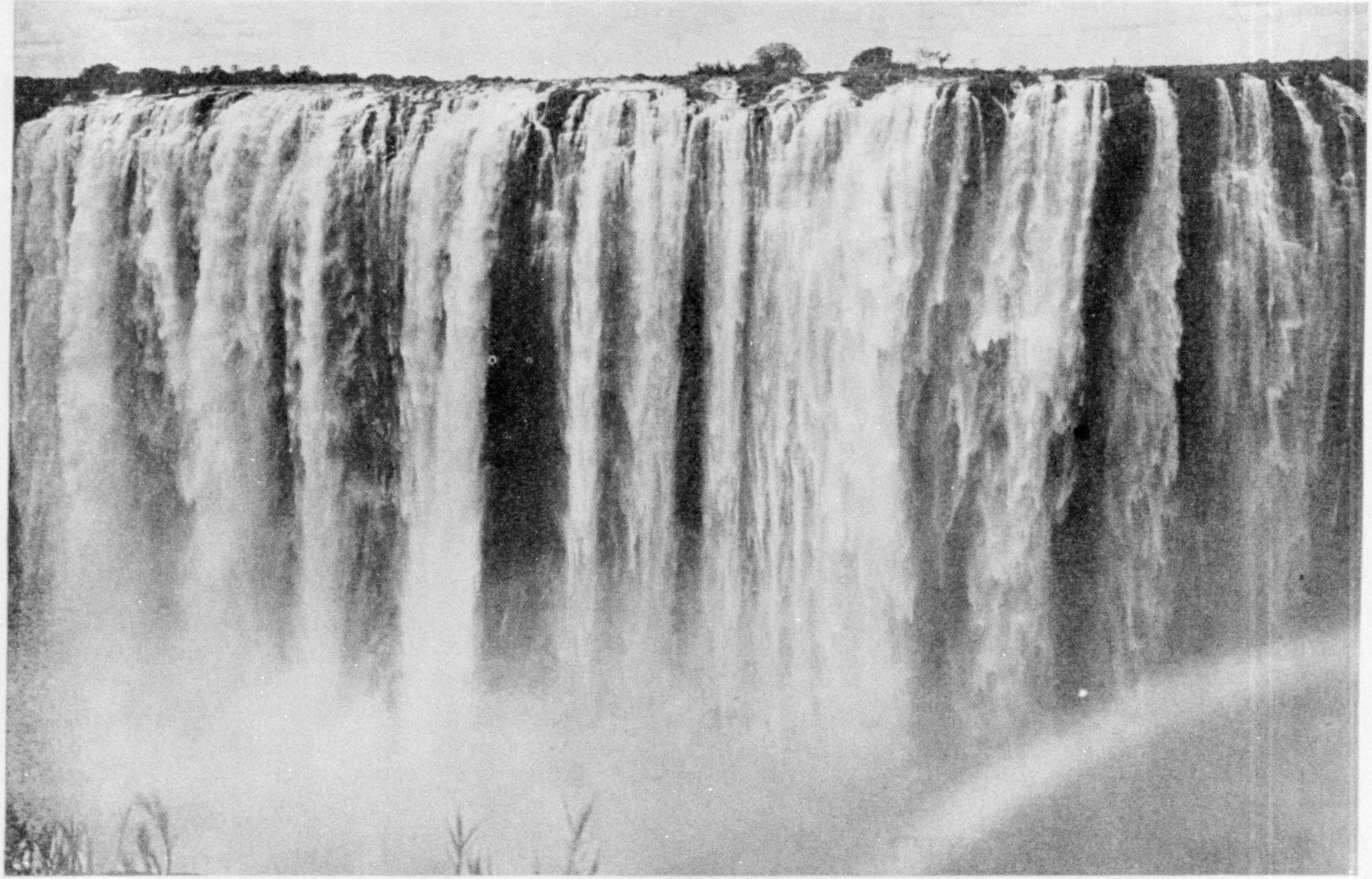
Nowadays, except at the time of high water, one can cross by boat above the falls the half mile of rapids which separates Brazil from Argentina. In crossing, we shoot with currents; we crawl against currents; we dodge projecting rocks, sometimes scraping them; we hug the


The height of the falls varies from 360—400 feet
width of chasm 6225 feet
U.S. Capitol
307 feet high
Leaping Water
Main Fall
Rainbow Fall
Eastern Cataract
Washington Monument, 555 feet high.
White House
DISTANCE FROM THE CAPITOL TO THE WHITE HOUSE ALONG PENNSYLVANIA AVENUE — 8350 FEET.
Zambezi River
Stony, wooded slope to water
Rough, stony country
Livingstone Island
Boaruka Island
The Chasm
Rain Forest
Danger Point
Knife Edge
Palm Kloof
Gorge
from Bulawayo
from Cairo
Railway Br.
420 feet above river
650 feet long
Boiling Pot
Grand Canyon

Drawing by Charles E. Riddiford

PANORAMIC PLAN OF VICTORIA FALLS

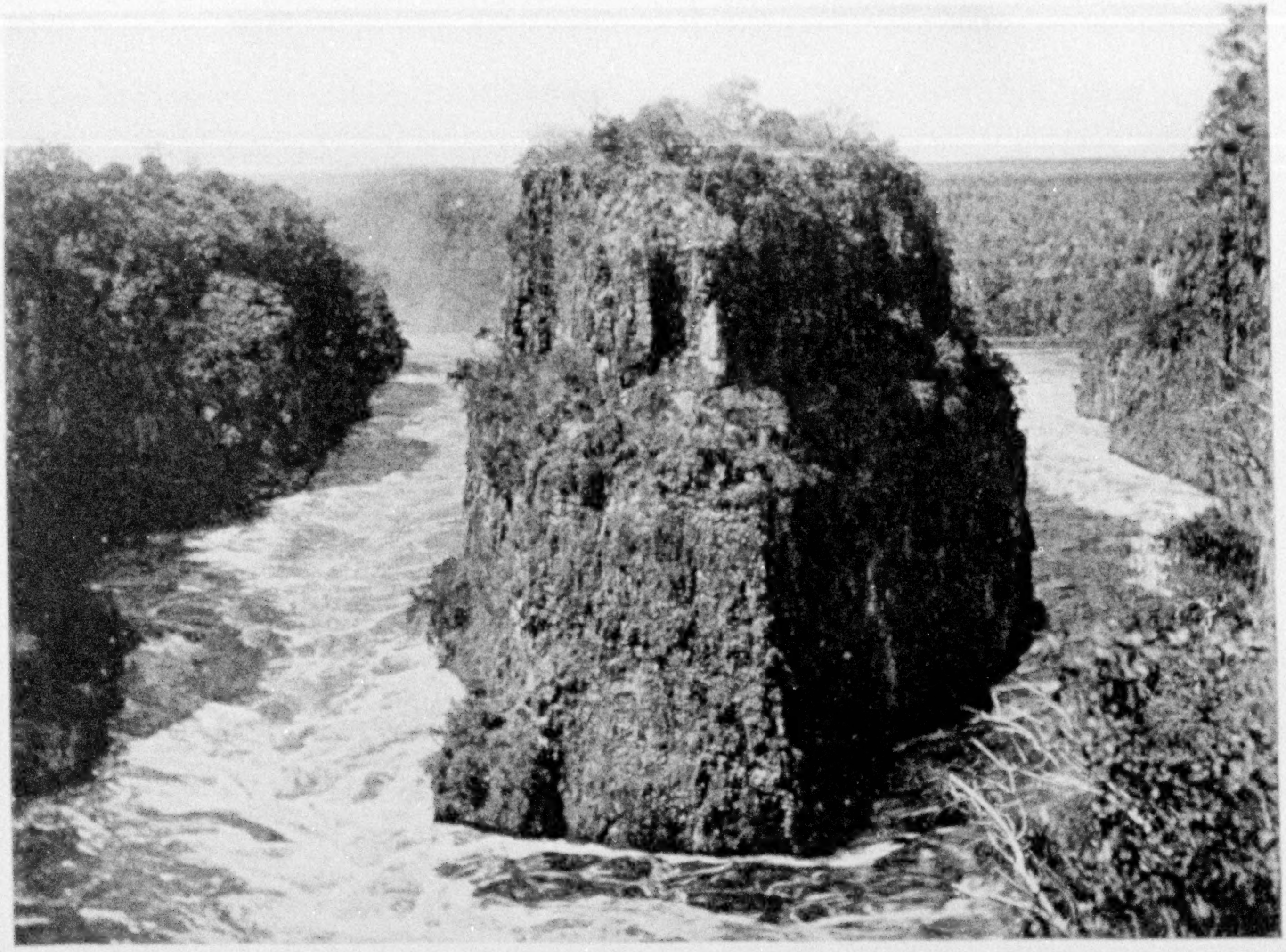
This drawing gives a vivid impression of the height and width of Victoria Falls and of the falls chasm. In the upper sketch the falls, 5,700 feet wide and from 360 to 400 feet high, and the chasm, 6,225 feet wide, are superimposed upon Pennsylvania Avenue between the Capitol, Washington Monument, and the White House. The falls suggest a sheet of water descending from a height greater than the Capitol, two-thirds as high as the Washington Monument, and stretching from the Capitol to the Treasury Building. A panoramic view of the front of the falls' precipice is also given, beginning with Devil's Cataract, or Leaping Water, at the west end of the chasm, and picturing in succession Cataract, or Boaruka, Island, the Main Fall, Livingstone Island, Rainbow Fall, and at the east end the Eastern Cataract (see text, page 36).



© L. Pedrotti

RAINBOW FALL FROM NEAR DANGER POINT: VICTORIA FALLS

At low water this exquisite spectacle appears as a hundred white cascades separated by narrow sections of black rock on the lip and down the side. Sunshine tints the spray with brilliant rainbows.



Photograph from Gardiner F. Williams

THE FIRST GREAT BEND IN CANYON GORGE BELOW VICTORIA FALLS

Below the falls, after the short turn at the whirlpool, rises a well-wooded, precipitous promontory, yellowish gray and red, between 300 and 400 feet high. On the left is a canyon down which the Zambezi rushes toward the spectator, and on the right is a similar canyon, down which it rushes away.

sides of little islets, dashing for areas of safety from one to another.

From the Brazilian boat landing we climb to the unfinished Brazilian Hotel at the top of a hill that commands the finest, highest view in all the falls region. It even looks down upon the hill across the Iguazu on which the red-roofed bungalow Argentine Hotel is built, and overlooks an extensive area of the bed and forest-clothed valley of the Iguazu above and below the falls and far back on the plateau (see page 57).

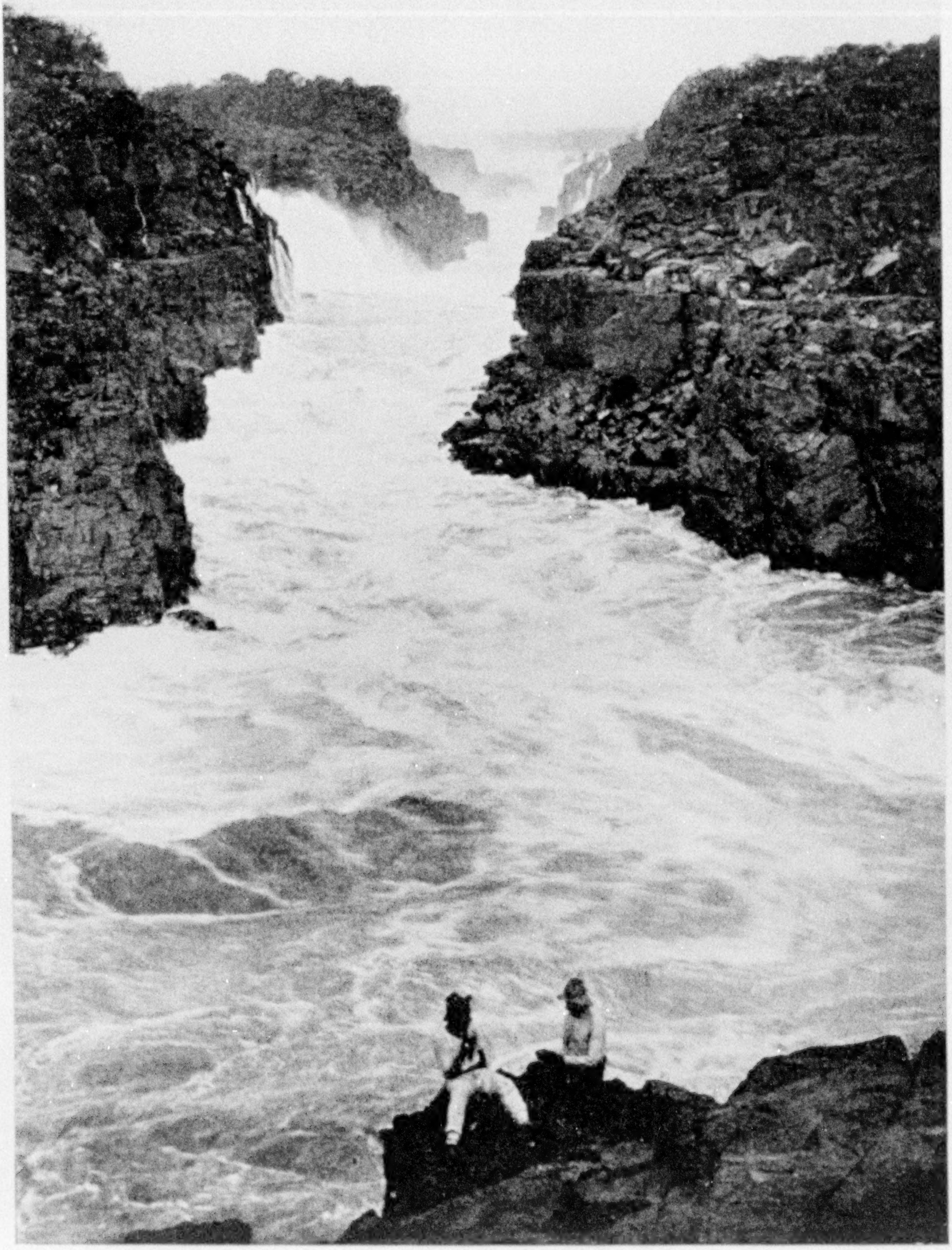
From this hilltop we see San Martín's many cataracts and the Three Musketeers in Argentina, broad, shallow, picturesque, and from the hillside lower down we see the falls of Devil's Throat, both Brazilian and Argentine, Floriano, Union, Rivadavia, and Belgrano.

As the most comprehensive single view and some views that are exclusive and unique of the Argentine falls are from the Brazilian side, so the finest views of the Brazilian falls are from the Argentine side; and the conclusion inevitably reached emphasizes the necessity of seeing the Iguazu falls from both sides of the river if our understanding and appreciation of them are to be complete.

Having pictured separately the distinguishing characteristics of the great waterfalls, it may be of interest to consider them together in detail, in a competitive comparison of their main elements of greatness.

COMPARISONS OF NIAGARA, VICTORIA, AND IGUAZU

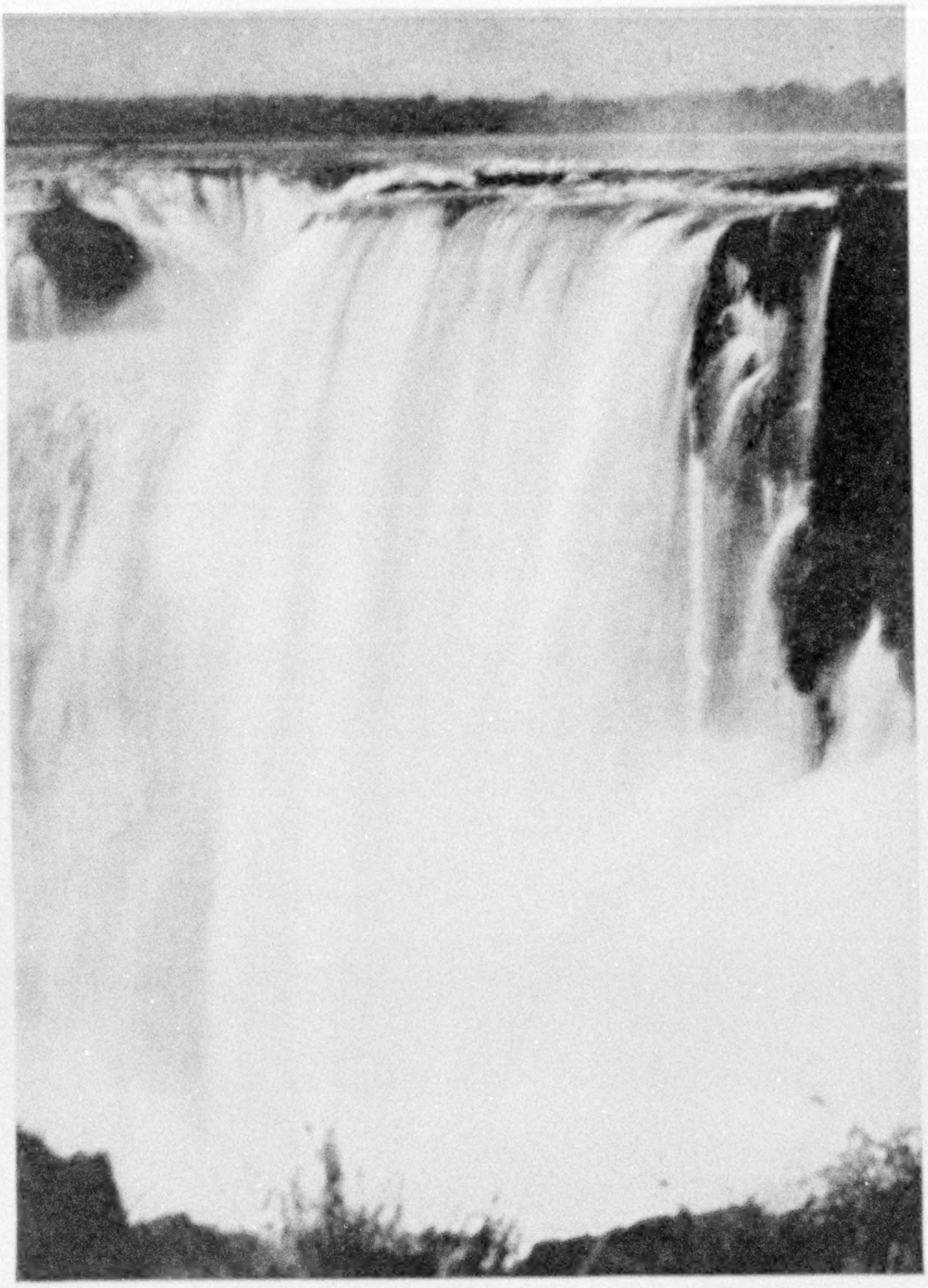
Niagara's *height* of fall ranges from 158 feet (Horseshoe or Canadian) to 167 feet (American). Victoria's heights range from 260 to 380 and 400 feet. Iguazu's maximum height of fall ranges, according to different estimates, from 213 to 230 feet. Most of Iguazu's cataracts are broken half way by a projecting shelf of rock of varying width, which often makes



Photograph by Pierce G. Shaw

THE FINEST CATARACTS IN SOUTH AMERICA: LA GUAYRA FALLS, BRAZIL

While the Paraná is in Brazil, and 125 miles from Iguazu Falls, the river descends from the plateau in a succession of short falls, separated by fierce rapids. La Guayra is not properly a waterfall, but a series of cataracts, dashing downhill in various directions, with a volume estimated at thirteen million cubic feet per second.



Photograph from Theodore W. Noyes

STRAIGHT HIGH SECTION OF UNION FALL

This is the highest column of Iguazu's descending waters, and the fall of which it is a part carries the greatest volume.

two cataracts out of one, each about 100 feet high.

At the lip of the precipice, Niagara (including Goat Island) has a total *width* of about 5,300 feet. Victoria (including Livingstone and Cataract islands) has a total width of about 5,700 feet. At the lip of the precipice, Iguazu (including the abnormally projecting island of San Martín) has a contour width (estimated) of more than 10,000 feet, or nearly two miles.

Niagara is the outlet seaward of the four western Great Lakes, which constitute half of the fresh water of the world. Almost unaffected by the seasons, the volume of water passing constantly over the falls in deep, broad stream is tremendous. Niagara below Grand Island is two and a half miles wide.

In similar relation to the fall, the Zambezi in flood is about two miles wide. It drains a large area, and whether at low or high water, is a great river. For a short period, when at highest flood, it may possibly compare in volume even with Niagara.

Iguazu carries the smallest volume of water of the three great falls. Its stream is not as broad as that of the Zambezi and neither so deep nor so broad as that of Niagara. It is swollen tremendously in flood, but so also is Zambezi.

RAPIDS OF THE THREE FALLS COMPARED

Niagara descends 52 feet in the last mile above the falls, flowing with immense velocity in turbulent, powerful, irresistible rapids.

Sections of the Zambezi next to the western and eastern banks, especially the former, descend in the swift rapids of the Devil's and Eastern cataracts shortly before taking the leap; but the great body of the river moves smoothly and slowly to the very edge of the chasm.

Iguazu's upper rapids, narrowed to one-half mile in width just before swerving in course and spreading out fanlike for the drop over the precipice in the San Martín section of the falls, are more turbulent and menacing than Zambezi's placid flow, but far less impressive than Niagara's raging, white-capped flood.

The chasm into which Niagara drops is 1,250 feet wide immediately at the falls, 800 feet wide two miles farther down, and at Whirlpool Rapids less than 300 feet wide.

Victoria Canyon is from 200 to 300 feet between walls, and the outlet gorges through which the Zambezi zigzags after the fall are in many places much narrower.

The Devil's Throat Chasm of the Iguazu is more than 200 feet deep and is short and narrow.

In the rapids below as well as above the falls, Niagara excels in mountainous waves of vast power in whirlpool and whirlpool rapids. The Zambezi, after falling edgewise in its narrow cleft, grips attention by the curiously shaped gorge through which, in deep, narrow rapids, it zigzags like a streak of lightning backward and forward in the earth's crust. Iguazu's gorge below the falls is commonplace compared with those of Niagara and Zambezi.

VISIBILITY OF FALLS COMPARED

Niagara can be seen as a whole with fine effect from the Canadian side, and in detail from every angle, from top to bottom, and at a few points from behind, as well as in front of its descending waters.

Victoria cannot be seen as a whole from any point, but can be viewed close at hand, when the spray permits, from the Rain Forest precipice in front for the entire length of the fall.

San Martin Island so projects itself as to shut out any view of Iguazu Falls as a whole; but the San Martin section can be seen well from the side of the precipitous hill on which the Argentine Hotel stands, and also in a fine, comprehensive, though somewhat remote, view from the Brazilian side of the river. The Devil's Throat section can be seen close at hand from a rocky islet in Argentina at the precipitous edge of Devil's Throat Chasm.

What have Niagara, Zambezi, and Iguazu, personified, to say for themselves as champions of their own greatness?

Niagara exclaims:

"I am the greatest body of falling water in the world.

"My watershed is that of four great lakes; my source is Lake Superior.

"No other falling water conveys so distinct a sense of overwhelming power.

"My attributes of might do not diminish my artistic beauty.

"No other falling water surpasses mine in the loveliness of lines of purity and simplicity.

"Of unadorned loveliness in summer; in winter my form is clothed with icy lacework and embroidery, enhancing its allurement."

Zambezi maintains:

"I am the greatest river in the world which casts itself in full volume over a precipice.

"The cliff over which I plunge is twice as high as that of Niagara and stretches more than a full mile in width.

"No other falling water roars so thunderously in token of its might; or, varying its symbol of power, no other falling water sends so high in air, to merge in the clouds, its column of mist and spray.

"Niagara boasts that Lake Superior is its source, and thereby confesses, being far greater at its source than at its mouth, that it is not a real river at all, but a drainway, conveying the excess water of four great lakes from Lake Erie, a few hundred feet downhill, to Lake Ontario. It has only the individuality and the artistic beauty of a natural drainage canal of extraordinary depth and breadth and vast water-carrying capacity.

"My strength and my beauty are my own. From source to ocean, I am Zambezi."

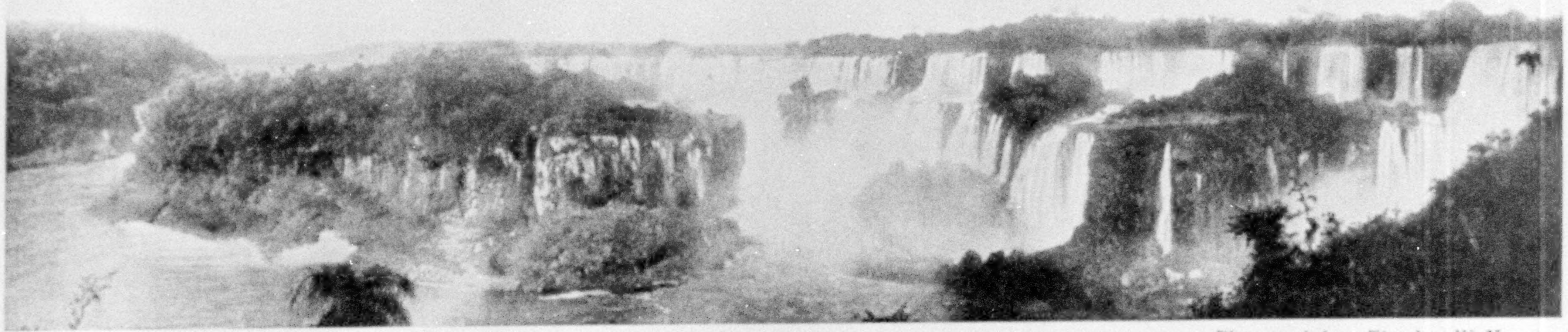
Iguazu speaks last:

"Nearly half as high again as Niagara in my highest fall, I am the broadest of the world's great cataracts and first in loveliness of form and artistic environment and in eye-impressing exploitation of my falling waters.

"Niagara, unduly concentrating its waters and thus diminishing spectacular effectiveness, sends 94 per cent of its vast volume over the precipice in a single sheet, at some points 30 feet deep.

"Zambezi's fall is not an exploitation, but a concealment, a vanishing act—the Great Disappearance. You see the great river a mile wide, and then you cease to see it, for it has fallen into a deep, narrow crack in the earth and is standing sidewise, on end, at the bottom of the crack, and is hiding itself there in clouds of drenching spray.

"To give pleasure to the eyes of man,



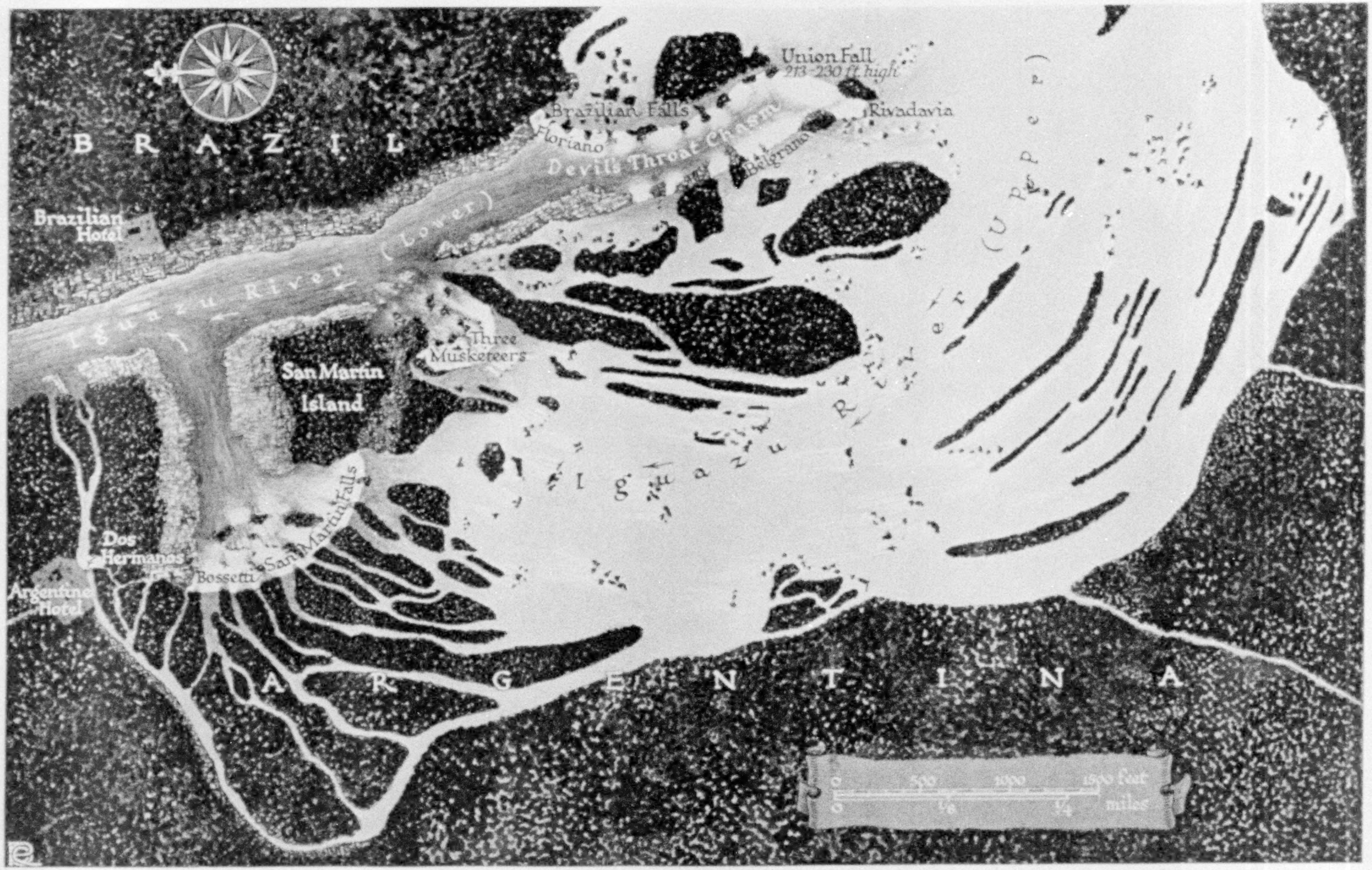
Photograph from Theodore W. Noyes

NEAR PANORAMIC VIEW OF IGUAZU FALLS

This view presents the full front of the falls' precipice in Argentina, with Bossetti and San Martín Falls semicircle from right to center, with San Martín Island from center to left, and with Brazil at the extreme left. It fails, however, to give an adequate idea of Iguazu, since the highest falls and the greatest volume of descending water are hidden behind San Martín Island in Devil's Throat Chasm, a deep and narrow canyon, into which the Brazilian falls, the great Union Fall (partly Brazilian, partly Argentine), and a few notable Argentine falls descend.

Photograph by L. M. Rossi

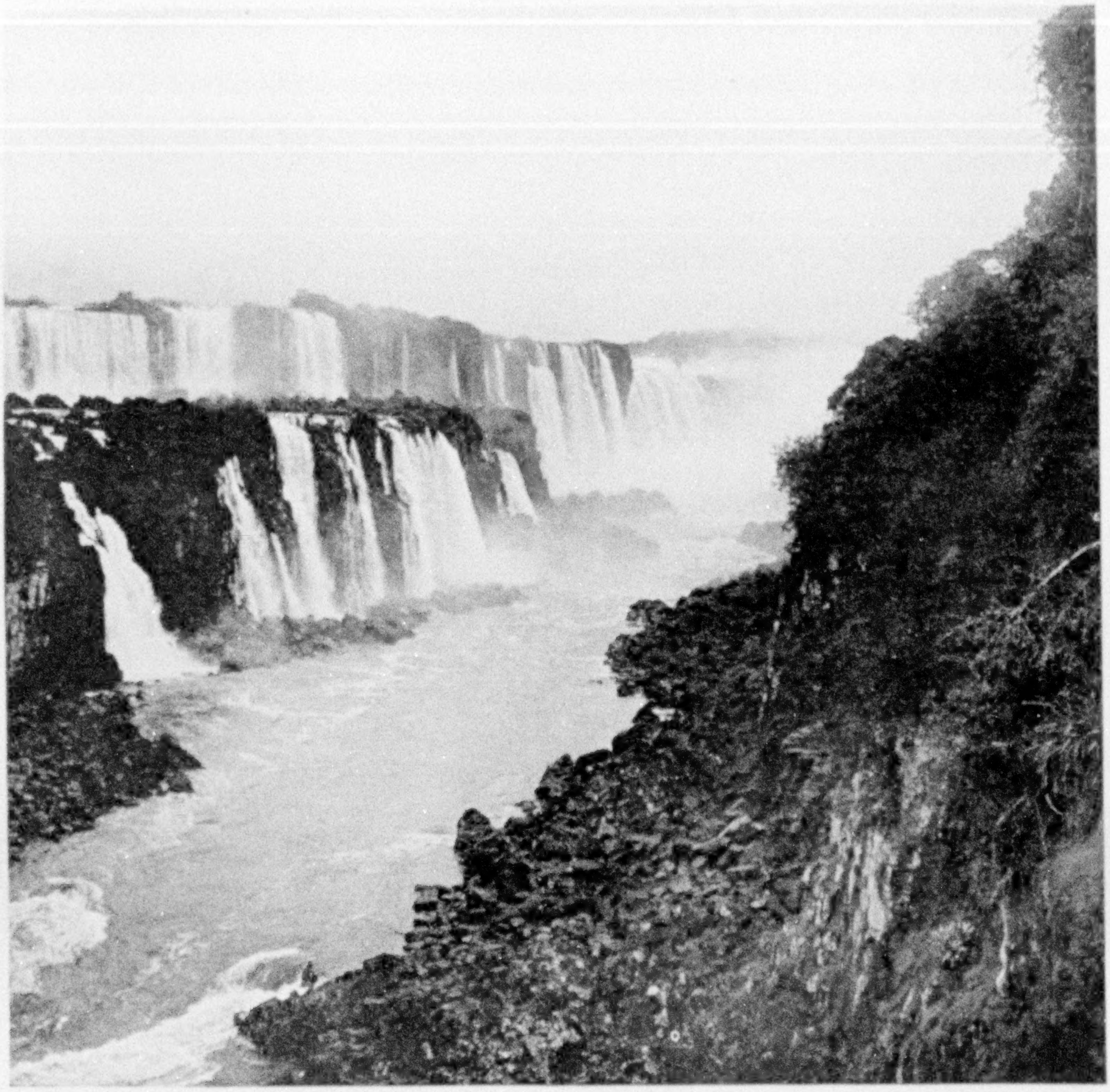
"THE WAR OF WATERS" AT IGUAZU


BRAZIL
Union Fall
213-230 ft. high
Brazilian Falls
Rivadavia
Floriano
Devil's Throat Chasm
Belgrano
Brazilian Hotel
(Lower)
Iguazu River
(Upper)
Iguazu River
Three Musketeers
San Martin Island
San Martin Falls
San Martin
Dos Hermanos
Bossetti
Argentine Hotel
ARGENTINA
0 500 1000 1500 feet
0 1/8 1/4 miles

Drawing by Charles E. Riddiford

PANORAMA ABOVE THE FALLS OF THE BROADEST OF THE WORLD'S CATARACTS: IGUAZU

Iguazu excels Niagara and Victoria in visibility, spreading out its waters and distributing them evenly over a vast area of precipice edge, so that a maximum impression of falling waters is gained. This pictorial diagram shows the rapids above the falls expanding fanlike just before plunging over the precipice. Note the location, not only of the main falls, Union and San Martin, but of the typical Iguazu cataracts, like Three Musketeers, Bossetti, Floriano, and Belgrano (see, also, pages 54 and 59).



Photograph from Theodore W. Noyes

THE SMOKE AND THUNDER OF DEVIL'S THROAT CHASM: IGUAZU

Down this deep, narrow canyon rushes the bulk of Iguazu's waters. From the Argentine side is seen San Martin Island to the right and Devil's Throat Rapids in the center. On the left is the precipitous bank of the Brazilian Iguazu, showing the Brazilian Falls, beginning with Floriano, largest of that group (left), and ending in the spray and mist of Union Fall, the greatest of Iguazu's cataracts, at the semicircular end of the chasm.

I display two main falls and a hundred cataracts, each beautiful in itself and in its environment, each framed in a setting of green of tropic vegetation.

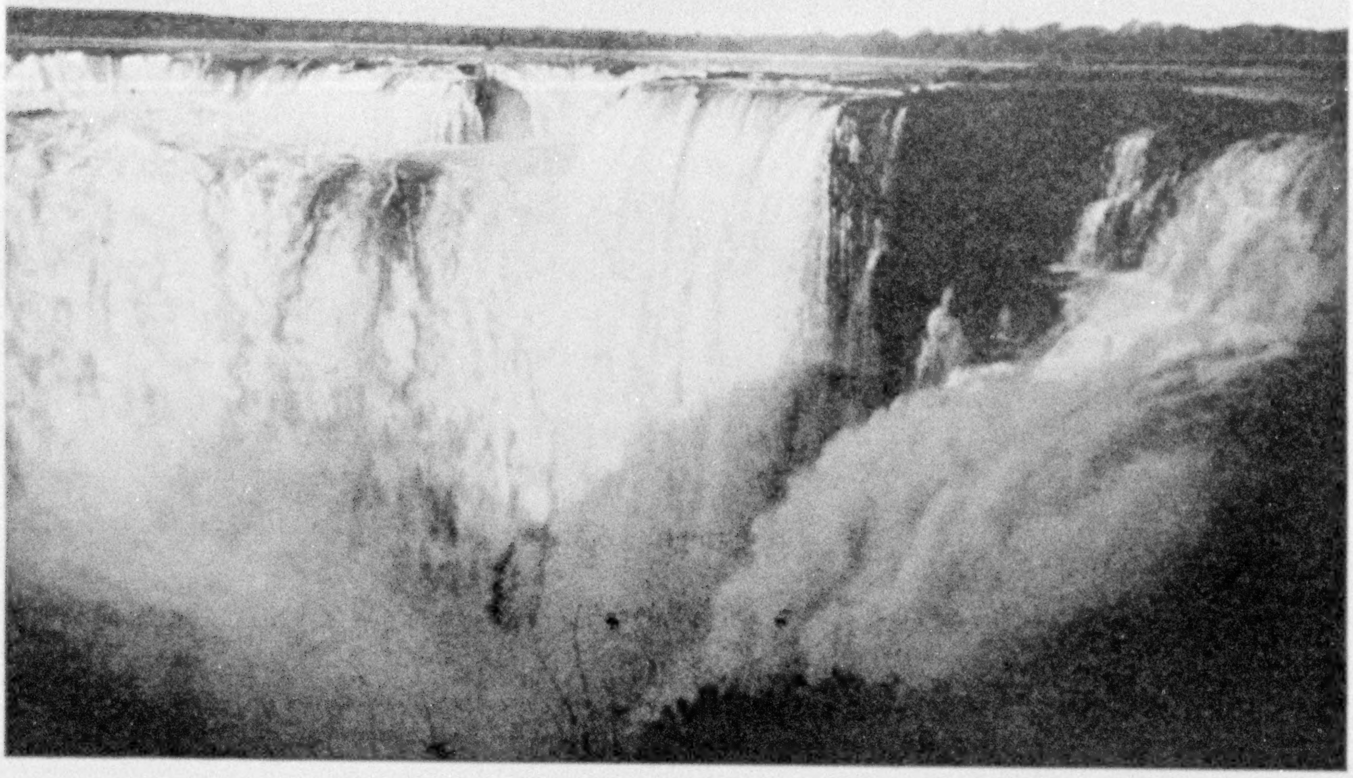
"In Devil's Throat I suggest a section of Zambezi Canyon in narrowness and depth of chasm and in spray clouds.

"In the vast semicircular sweep of the precipice over which San Martin falls, there is a suggestion in contour of Niagara.

"Thus I combine suggestions of the main visible characteristics of both Niagara and Zambezi.

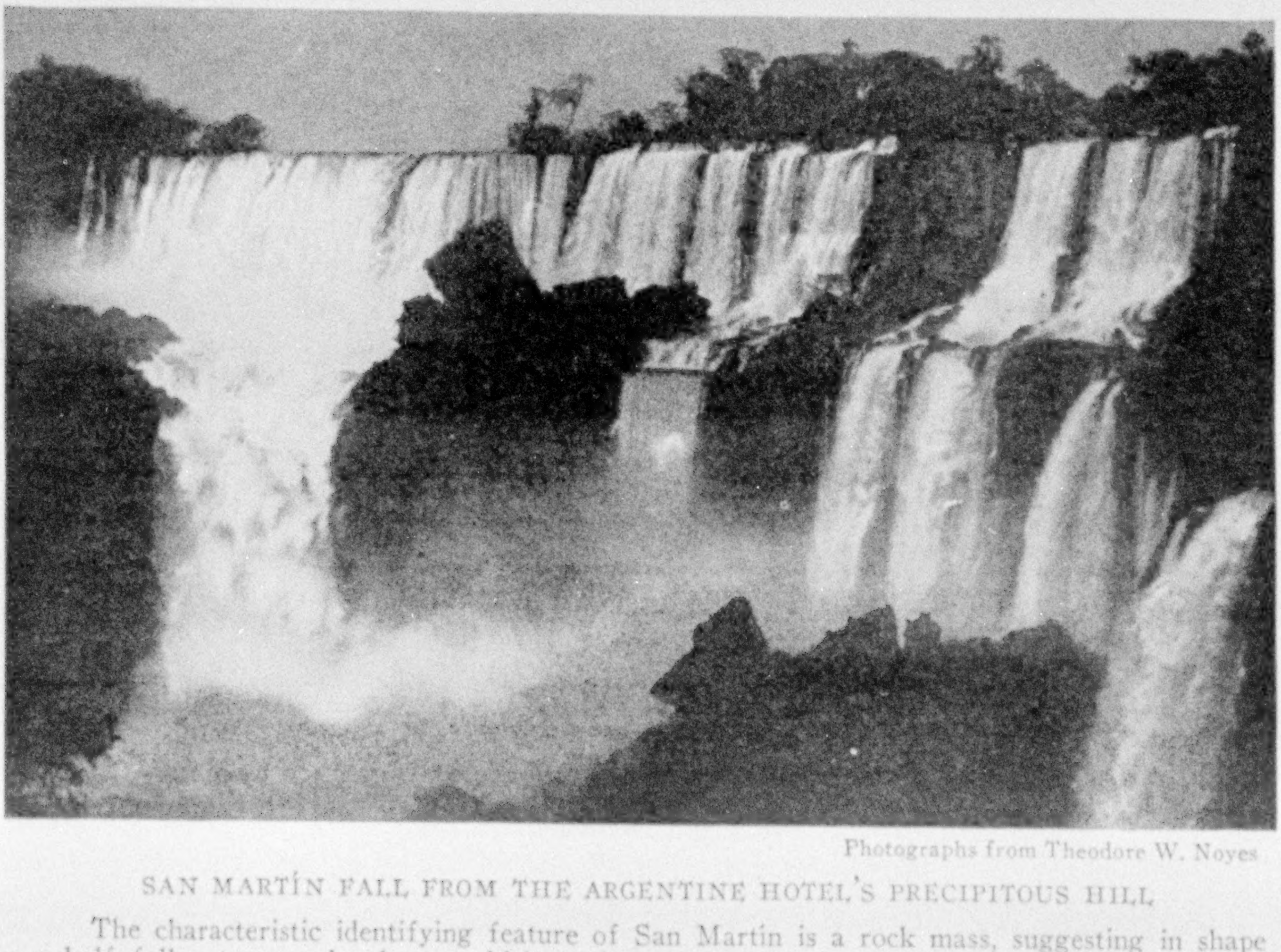
"I excel them both in the spectacular use I make, for the pleasure of the artistic eye, in diversity of form and alluring environment, of the volume of water entrusted to me for exploitation."

Each great fall is, in its own way, a wonderful exhibit of power and beauty. Each richly rewards the observant and appreciative visitor, and each must be visited and enjoyed by every one who would miss no atom of the inspiring thrill which comes to the initiate from observation of the might and loveliness of Nature's wonders.



TOP OF UNION FALL, DEVIL'S THROAT CHASM SEEN FROM AN ARGENTINE ISLET AT THE EDGE OF DEVIL'S THROAT CHASM

At the right Rivadavia Cataract hurls itself into the chasm. Then comes a tiny intervening islet at the precipice edge; then the high straight foaming creamy column of the first section of Union Fall, and then the typical top of Union Fall, with its eroded topmost section, which causes the river to drop 20 or 25 feet to a narrow shelf and then plunge in a single leap to the bottom of the chasm.



Photographs from Theodore W. Noyes

SAN MARTÍN FALL FROM THE ARGENTINE HOTEL'S PRECIPITOUS HILL

The characteristic identifying feature of San Martin is a rock mass, suggesting in shape a half fallen truncated column, which projects from the platform separating the upper and lower falls and which is outlined against the whiteness of the upper fall.

STREETS AND PALACES OF COLORFUL INDIA

With Illustrations from Natural Color Photographs by Gervais Courtellemont

IT IS difficult for the occidental mind to gain an accurate concept of India, as there is nothing in the Western World with which to compare it.

Many think of it as a deeply mysterious land of tigers, cobras, and cholera; others as a place of flashing jewels and colorful pageantry, liberally supplied with magnificent temples and palaces, imperious maharajas, and richly caparisoned elephants.

Each of these conceptions has some foundation in fact, yet neither of them expresses the real India. It is hard to generalize when speaking of a country nearly two-thirds as large as the United States and the home of a myriad races and religions; but, on the whole, India may be said to be a very hot portion of the earth's surface where 315 million people worship and pray to 330 million gods.

It is preëminently a land of amazing contrasts and flashing colors; a land where stupendous wealth and abject poverty, sublime beauty and revolting ugliness, live side by side.

For every wealthy nobleman in India, there are thousands of victims of privation. For every tile on a tinted roof, there are a thousand drab mud huts peopled by human beings whose clothing, poor and scanty as it is, serves to distinguish them from the beasts.

Poverty is so common that it ceases to be impressive; yet, with all the tragedy of its teeming millions, India is a colorful land. And it is this prevalence of color that tends to lift the life of its people beyond the realm of the commonplace.

In his dress and in the decoration of his buildings, the native of India indulges his love of bright colors, and the life of his cities often comprises a mosaic of tints and shades that is startling to behold.

BOMBAY, INDIA'S WESTERN GATEWAY

The western gateway to this land of color and contrast is the fine city of Bombay (see Color Plates II, V, VII, and XII), aptly described as being made up of equal portions of London and the Arabian Nights. Its sky line is as modern and imposing as that of Europe's metropolis, yet in many ways it is as truly oriental as any place in India.

Situated on an exceptionally fine harbor, this city, which has been an important trading center for nearly three centuries, is the industrial capital of Hindustan. Great factories surround it, belching out soot and smoke against the clear blue of the sky; but these black smudges are doomed. Modern engineering science has harnessed the monsoon rains up in the hills, and hydroelectric power is fast displacing dirtier and less efficient methods of turning factory wheels.

The Parsees are the most influential native people in Bombay, many of them having acquired great wealth and attained high social position.

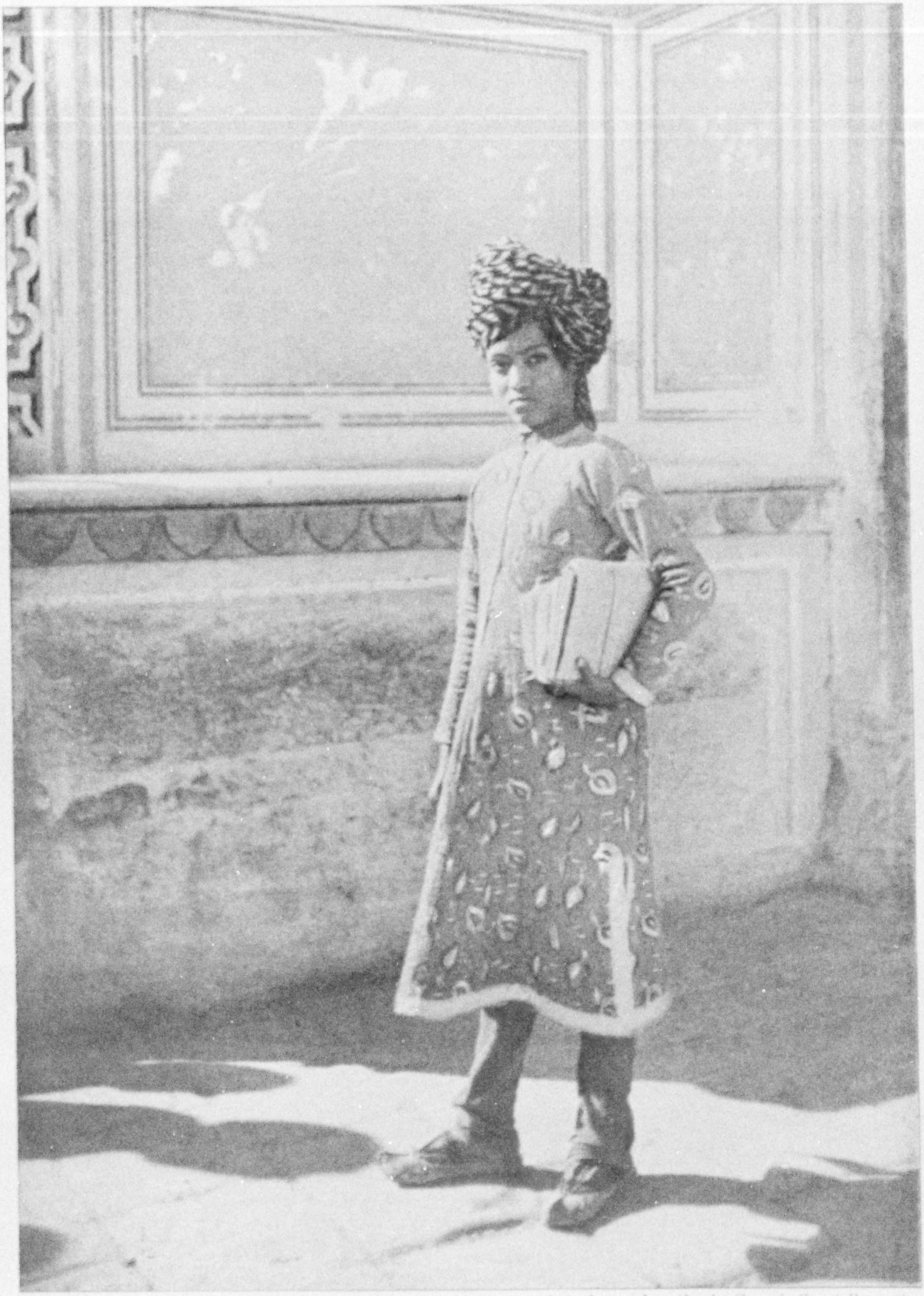
Among the strangest and most interesting sights of the city are the "Towers of Silence," to which the Parsees convey their dead. So holy are the elements to these followers of Zoroaster that they are unwilling to pollute fire, earth, or water, by cremating, burying, or committing the dead to the waves.

Surrounding the Towers of Silence is a beautiful garden, filled with flowers and shrubs and stately cypress trees, which commands an enchanting view of mountain and sea. Here the relatives of the departed come to meditate.

AHMADABAD IS KING COTTON'S INDIAN THRONE

Ahmadabad is a city where the contrast of old and new is most apparent. Founded over 500 years ago by Sultan Ahmad I, and more recently made famous as the home of Gandhi, this city was in the time of Queen Elizabeth as large as London. It was a center where the finest artisans of India gathered, and its silks, gold brocades, and objects made of mother-of-pearl were known the world over.

But King Cotton laid siege to the city and invested it with an army of 50,000 mill hands, who now toil at spindles, which have displaced the hand workers of another age. The circle of smudge-venting smokestacks pressing in upon this stronghold of a passing art was the force which roused Gandhi to strive against the



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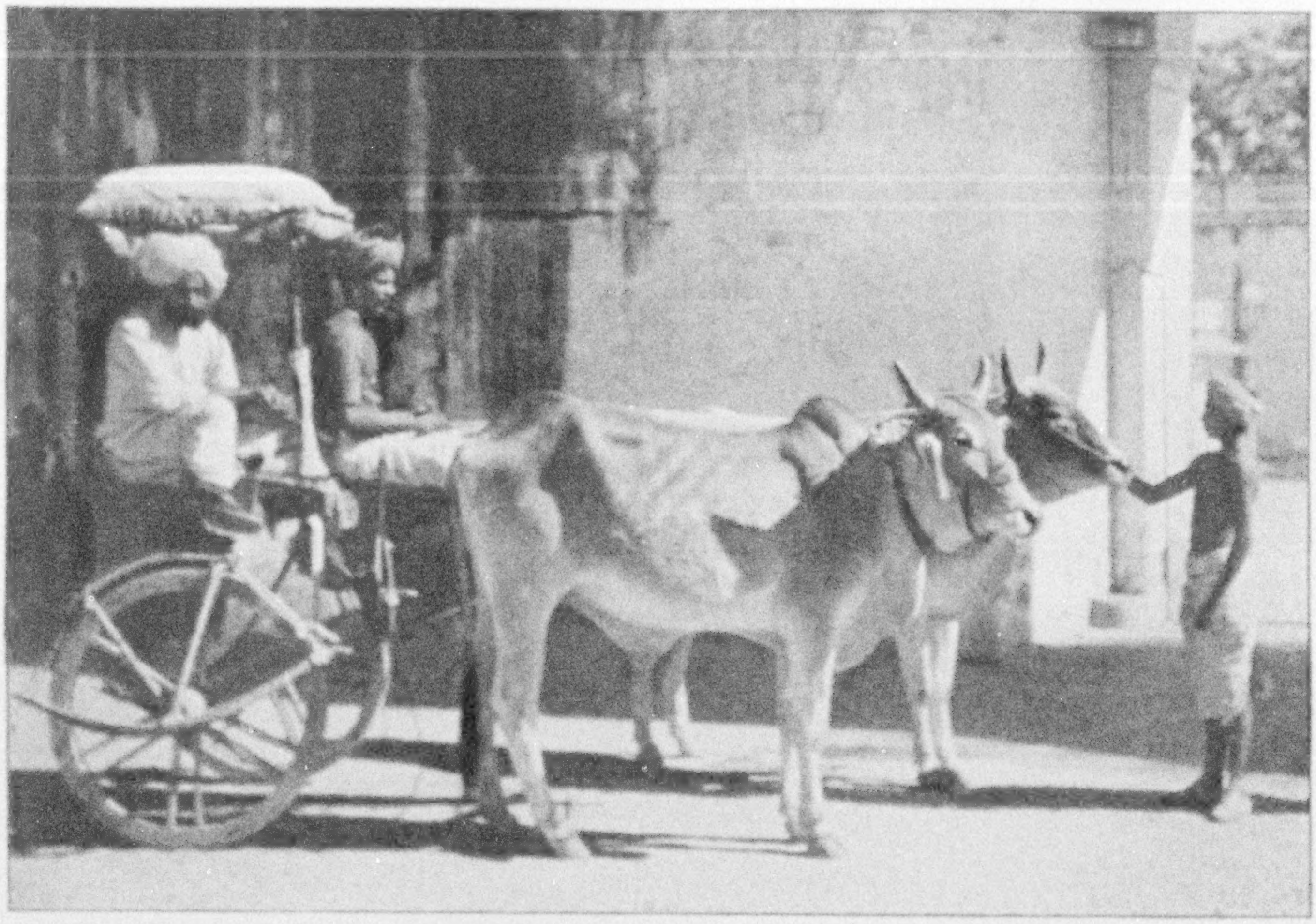
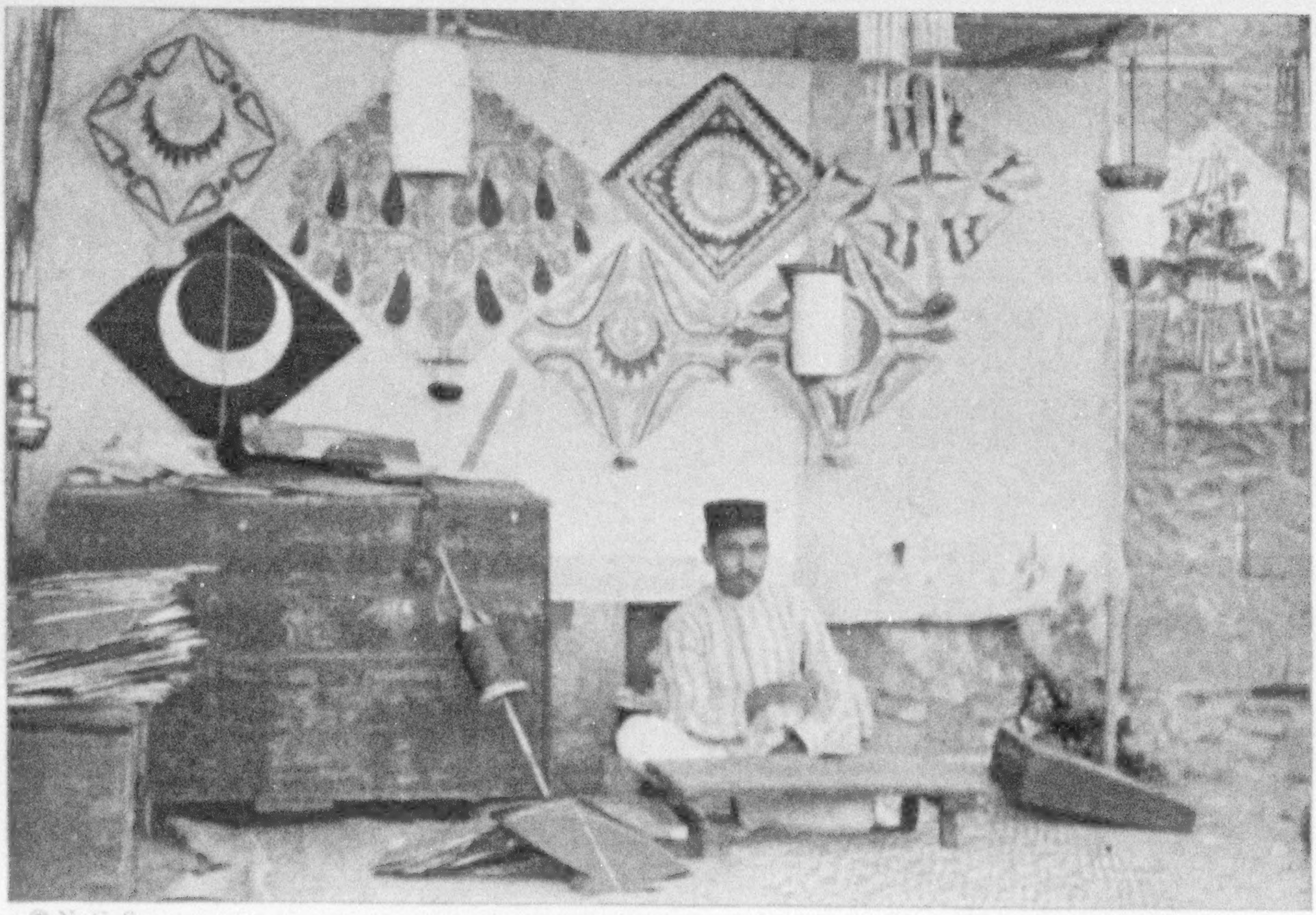
A YOUNG STUDENT OF HINDUSTAN

Education is progressing in India, but as yet the majority of the natives can neither read nor write. This youth hopes to win a coveted prize which gives promise of a government position. If he were a rajah's son, he would go to one of the four princes' colleges in India, and then possibly to a foreign university.



AN EQUIPAGE OF JAIPUR'S ARISTOCRACY



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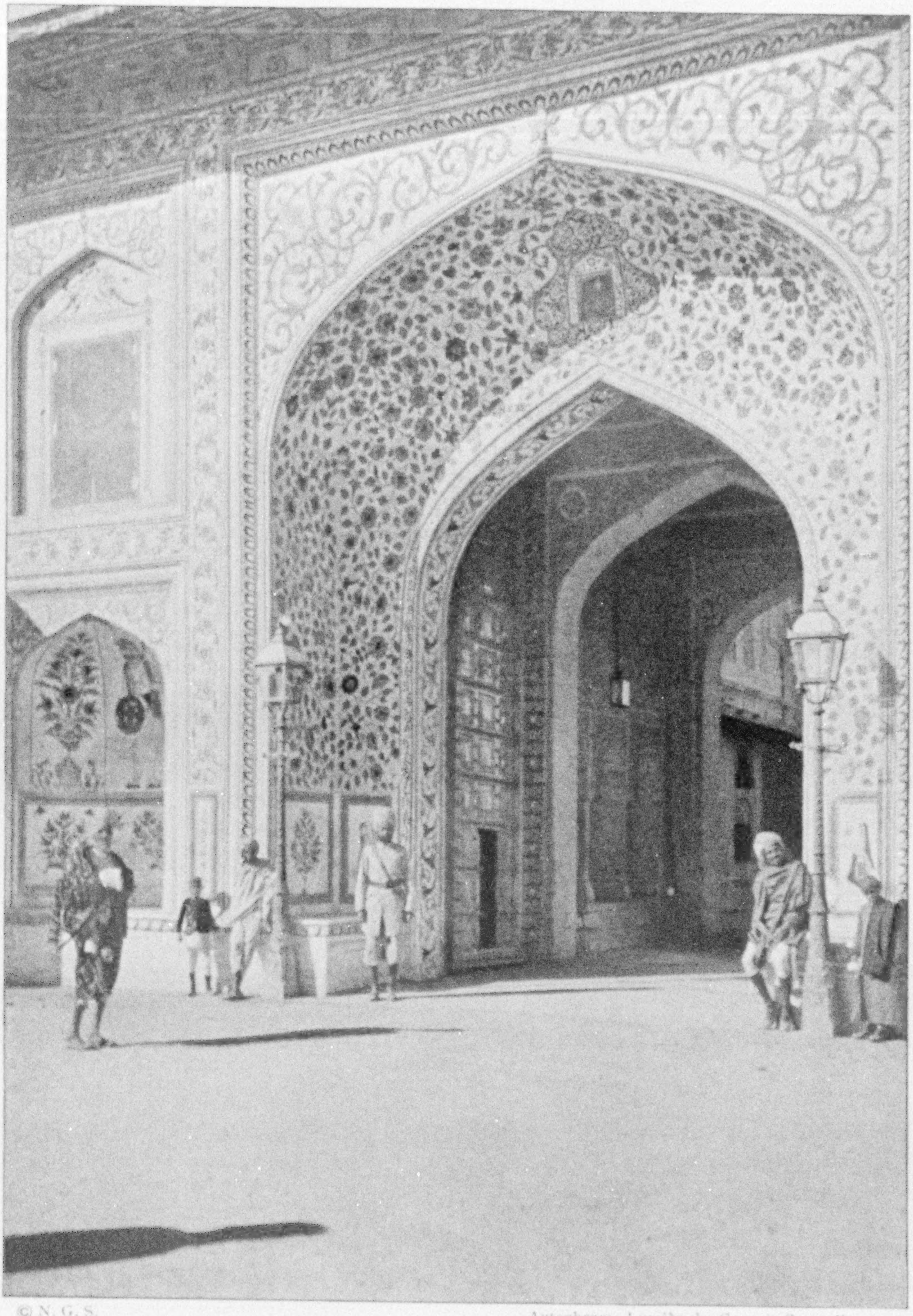
A KITE MERCHANT OF BOMBAY

His toy wares are made of paper, often decorated with brilliant colors. Kite flying is an exciting sport with Indian boys, for the purpose is to battle with each other's kites in the air.



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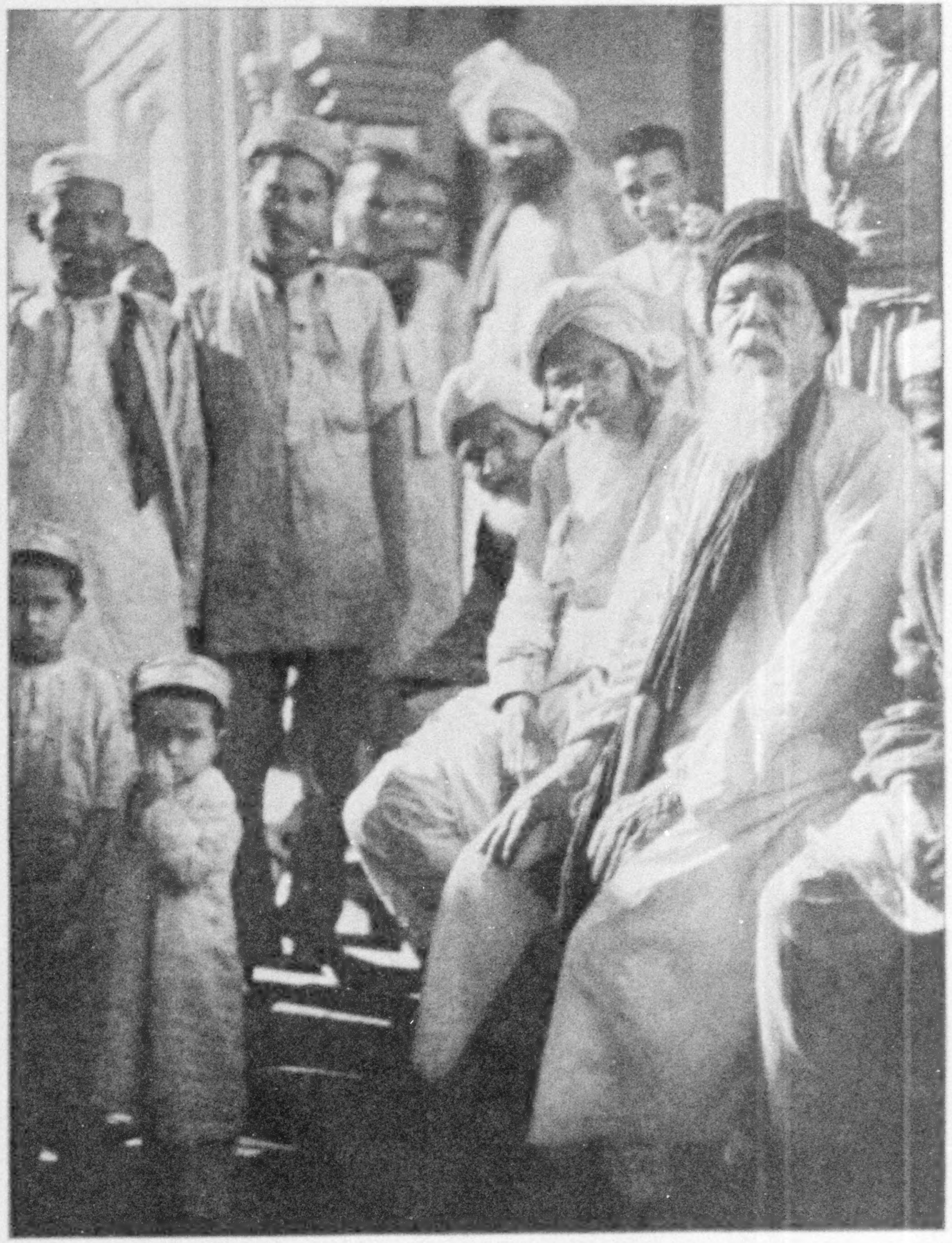
THE GORGEOUS SECOND ENTRANCE TO JAIPUR'S PALACE

From the pink-and-white tinted streets and houses of this "rose red" city, founded 200 years ago by the Maharaja Jai Singh II, the visitor passes into the royal palace. Everything in Jaipur, including the costumes of its people, runs to gay colors, and it is the only city in India which is laid out in rectangular blocks.

© N. G. S.

THE TURBAN—PICTURESQUE AND PRACTICAL

This Hindu's headgear, consisting of many yards of fine material, protects its wearer from tropical heat, and by its color, size and style of folding denotes his profession or rank.



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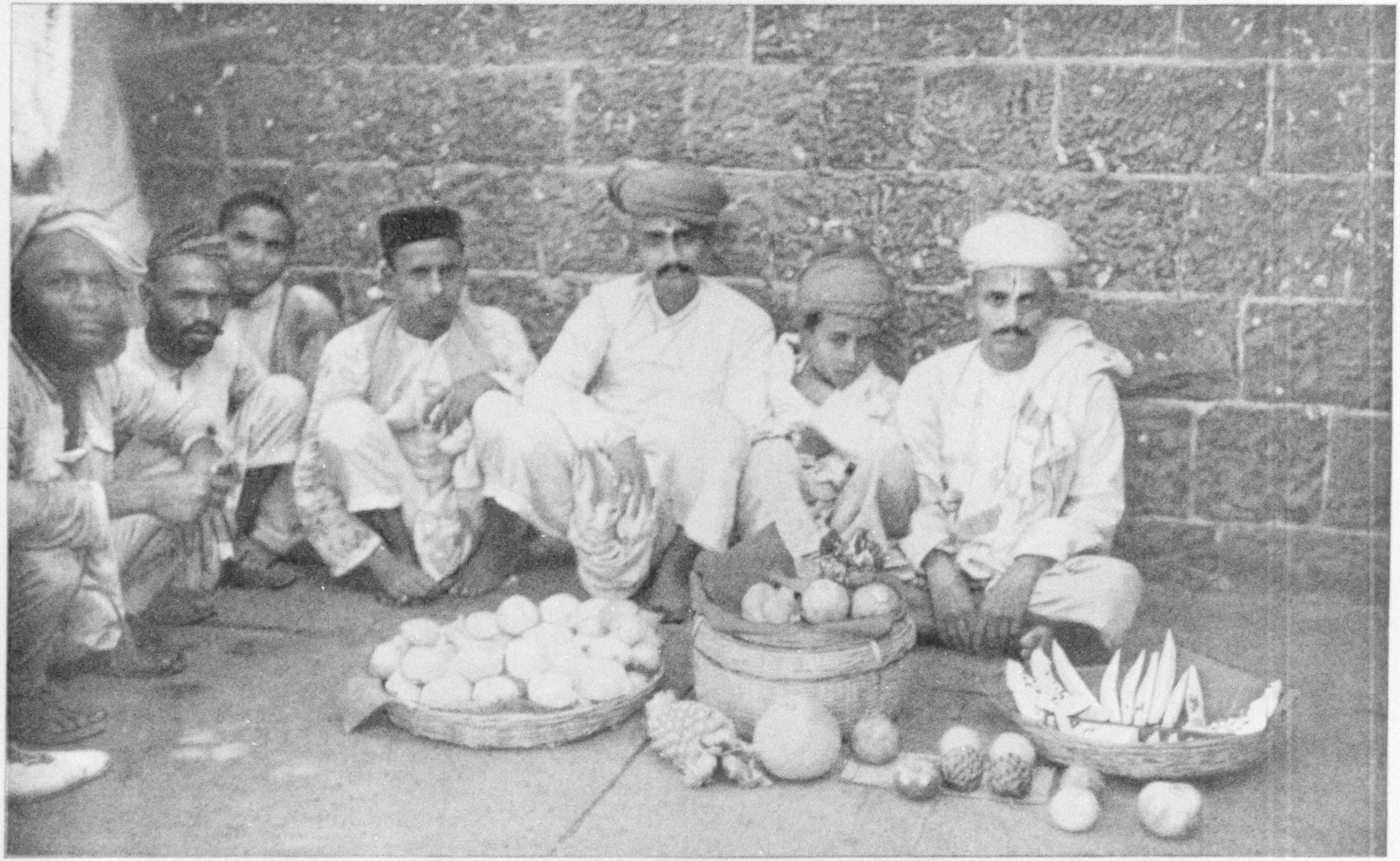
YOUTH AND AGE IN INDIA'S QUEEN CITY

Bombay is the western gateway and largest city of India. Its "man in the street," teeming in numbers, varied in type and dress, affords a wealth of human interest for the camera.



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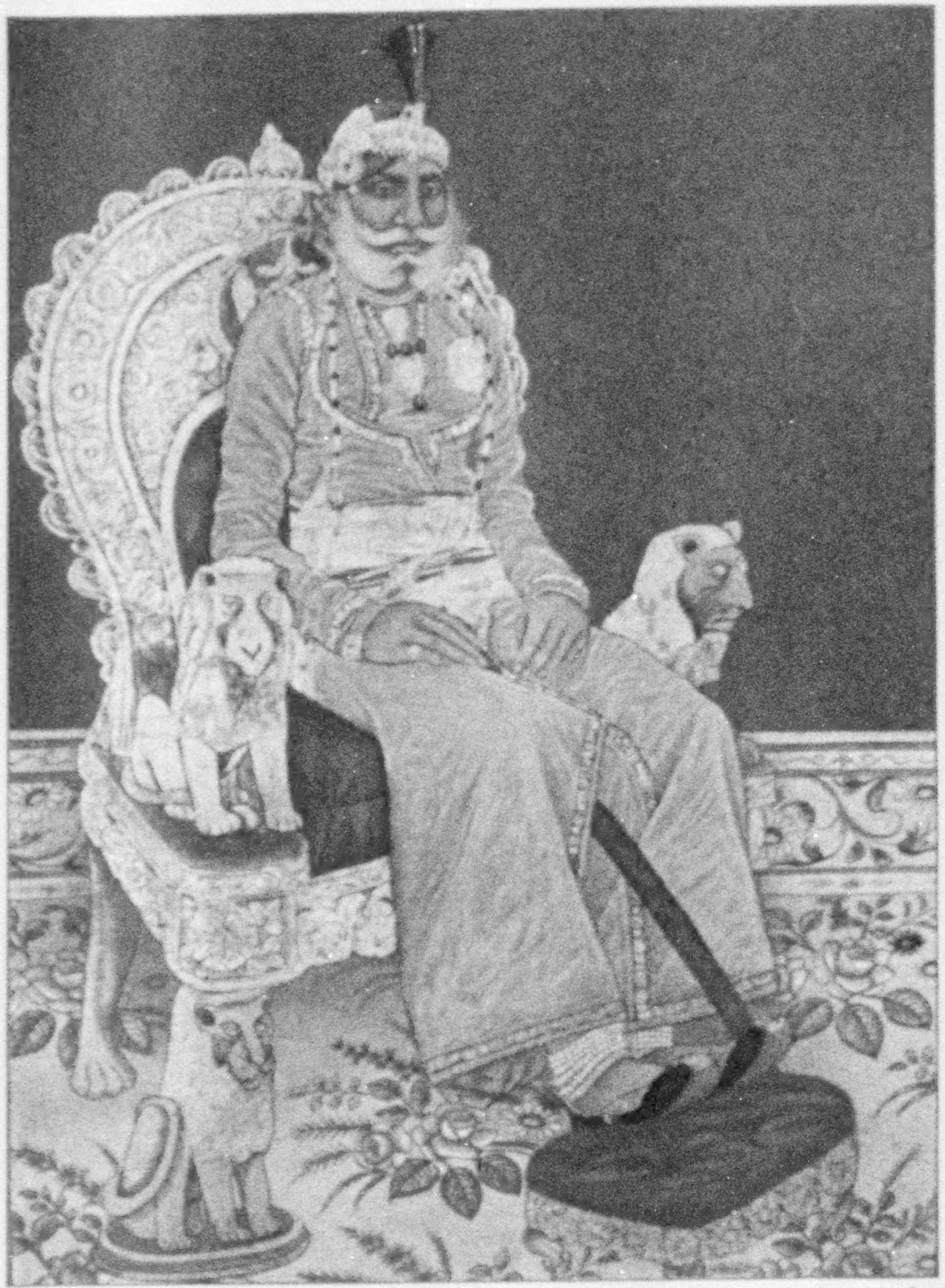
THE BOMBAY FRUIT MERCHANTS PRESENT THEIR TEMPTING ARRAY

These dealers preferably spread their wares in an open space in the lee of a wall with an awning to keep off the sun, but the stalls of the bazaars are also crowded with their heaps of golden oranges, guavas, melons and brilliant pomegranates.



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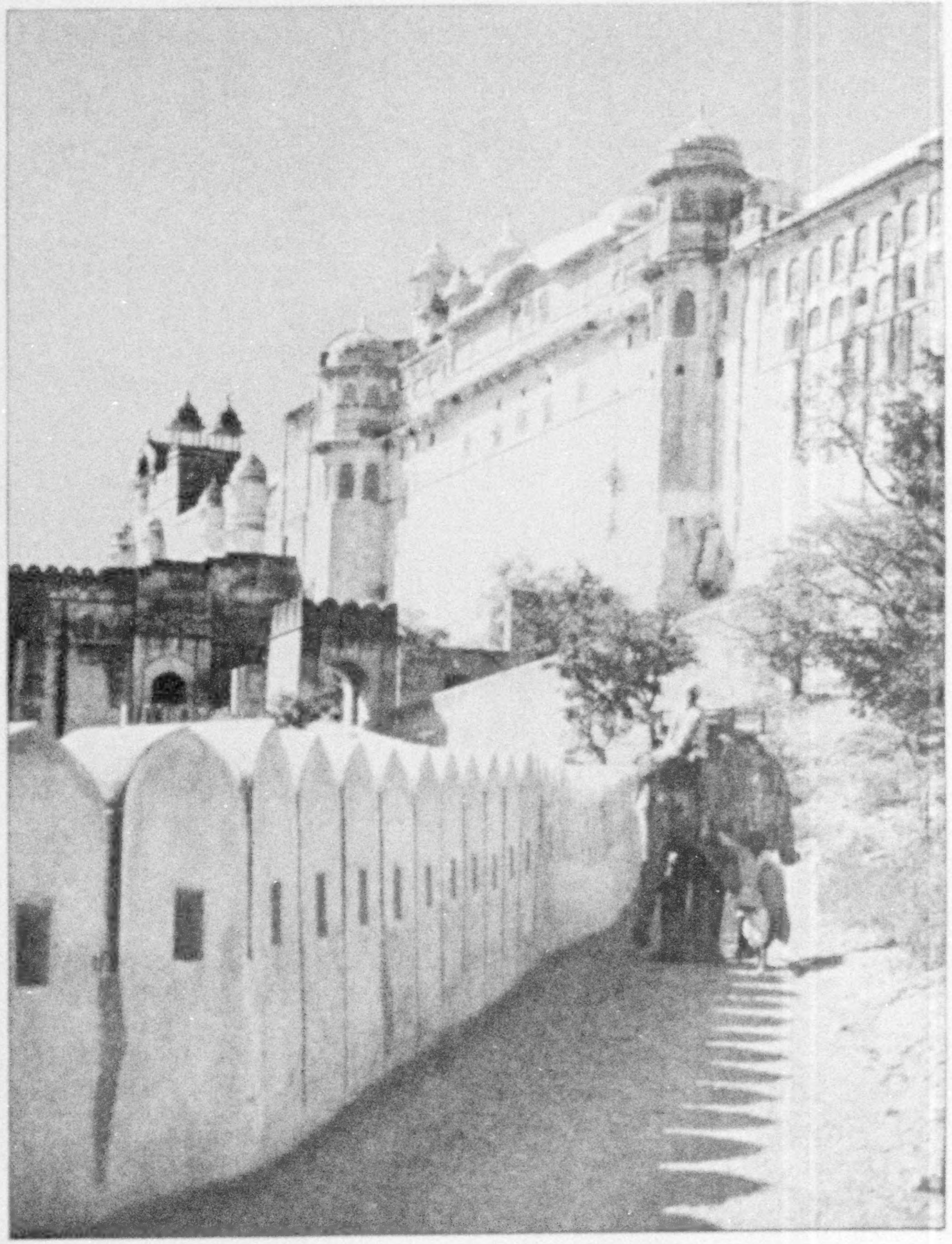
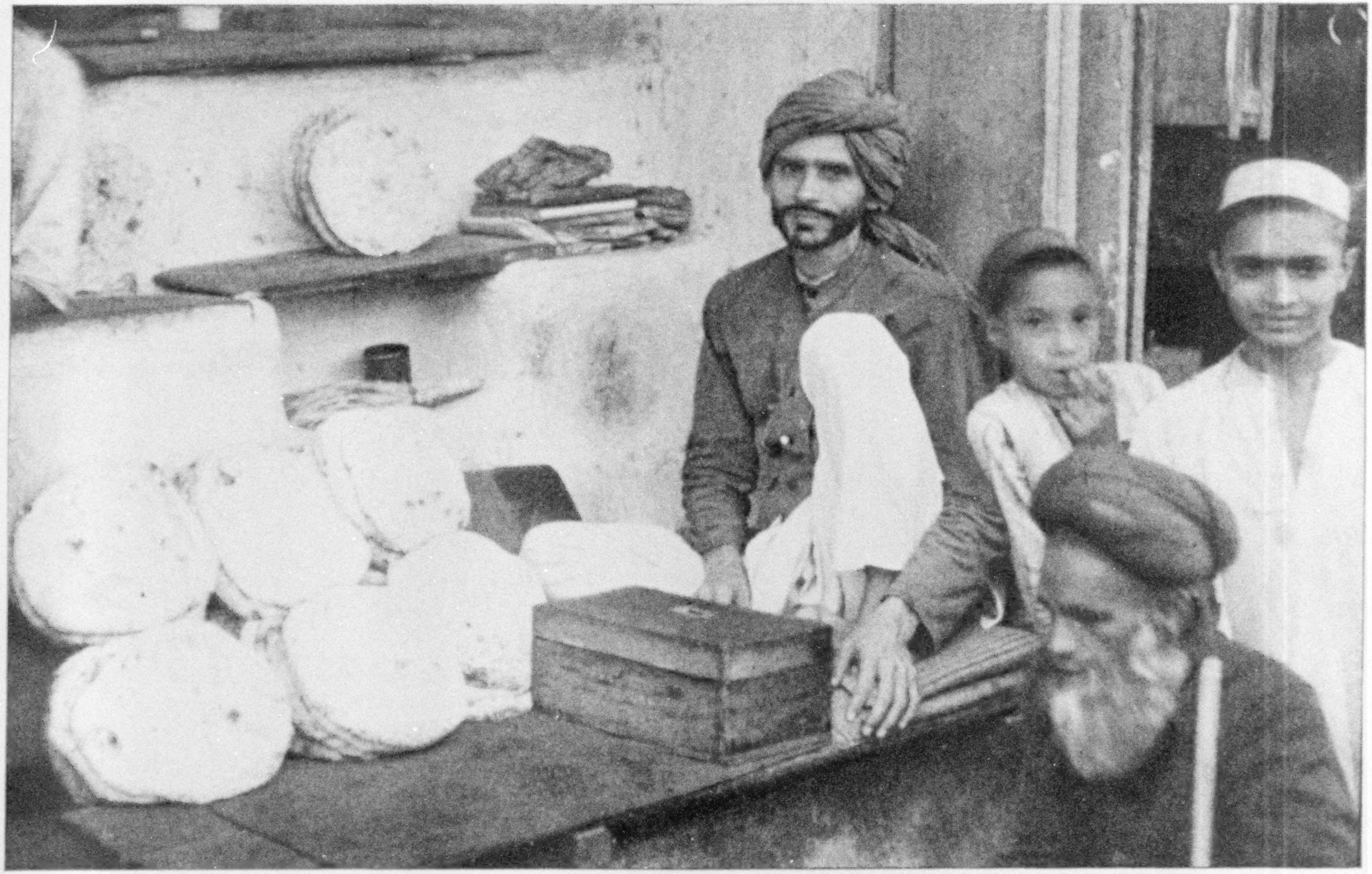
A JEWELED RULER OF A HAUGHTY STATE

Because of his blue blood and his traditional descent from the Sun God, the present Maharana of Udaipur claims superior rank to every other prince of India. He owns the famous marble dams of Rajputana (see the National Geographic Magazine for November, 1921).



THE ENTRANCE TO "THE CITY THAT WILL NEVER WAKE"

Hidden among the hills near Jaipur and picturesquely situated at the entrance to a rocky mountain gorge, Amber, once a capital where maharajas reigned in splendor, is now deserted and in ruins. Architecturally, its old palace ranks second only to that of Gwalior.



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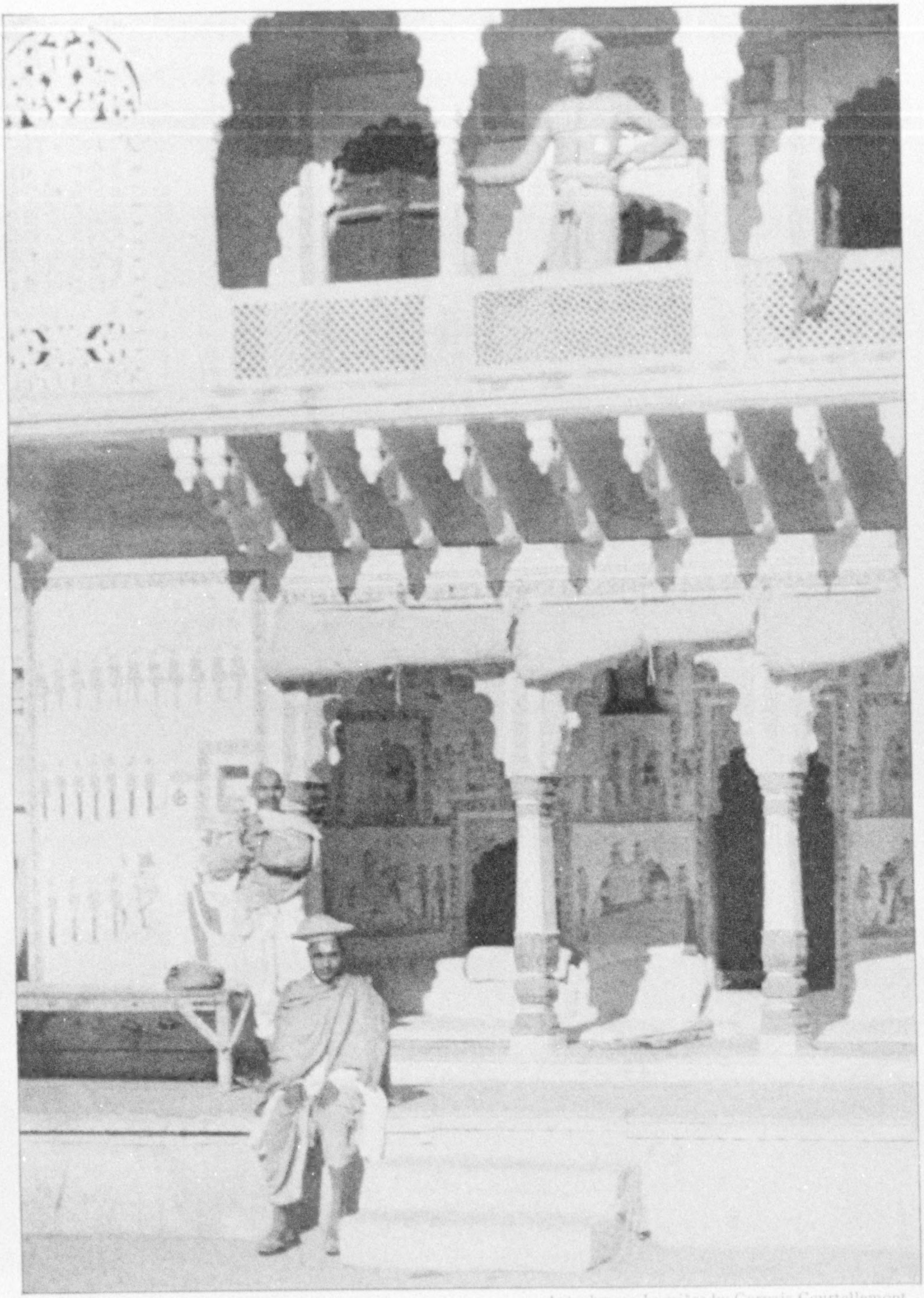
ONE OF BOMBAY'S BREAD MERCHANTS

Dough is made into thin pancakes, lightly baked on a hot plate, and eaten, preferably, while warm.



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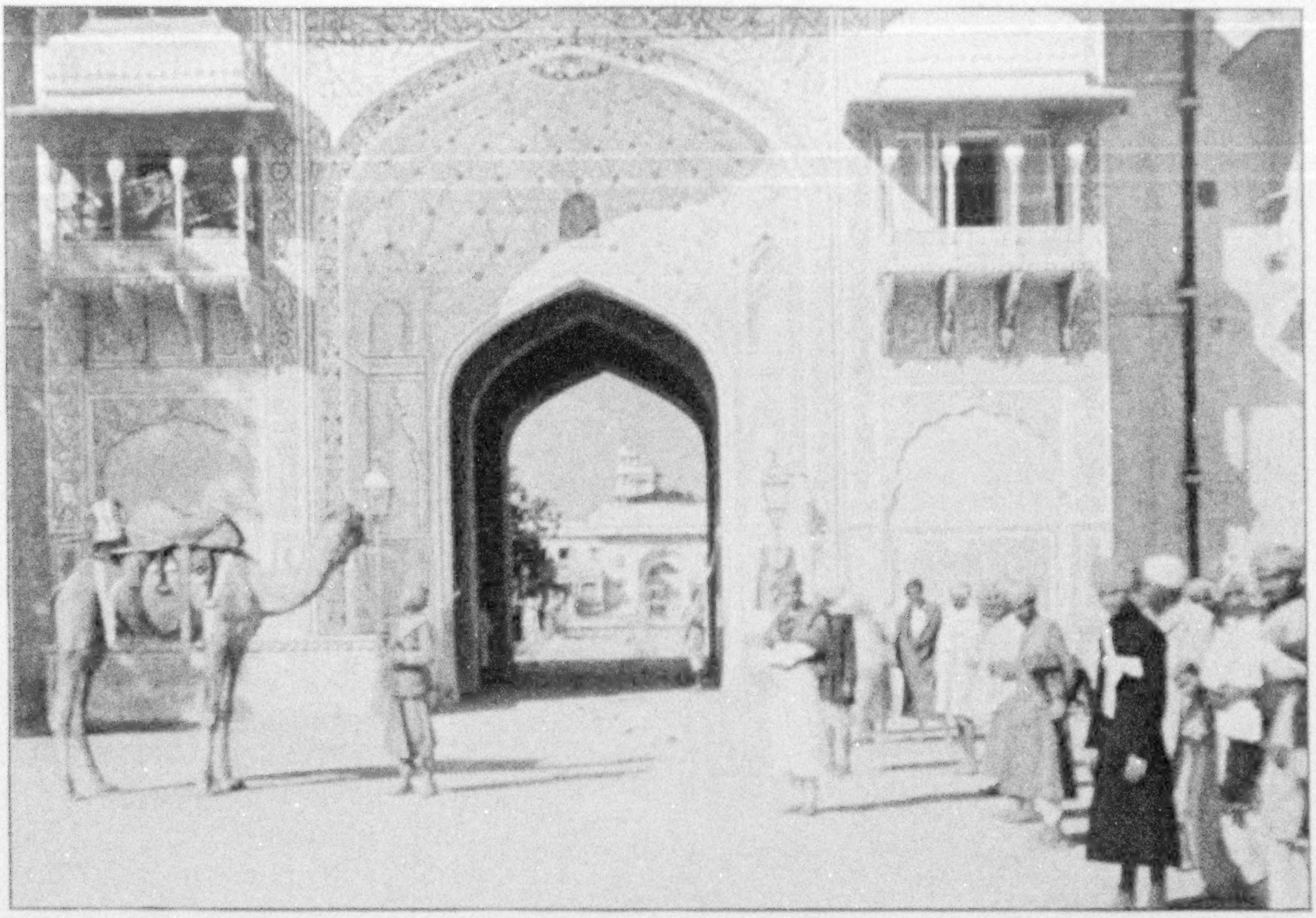
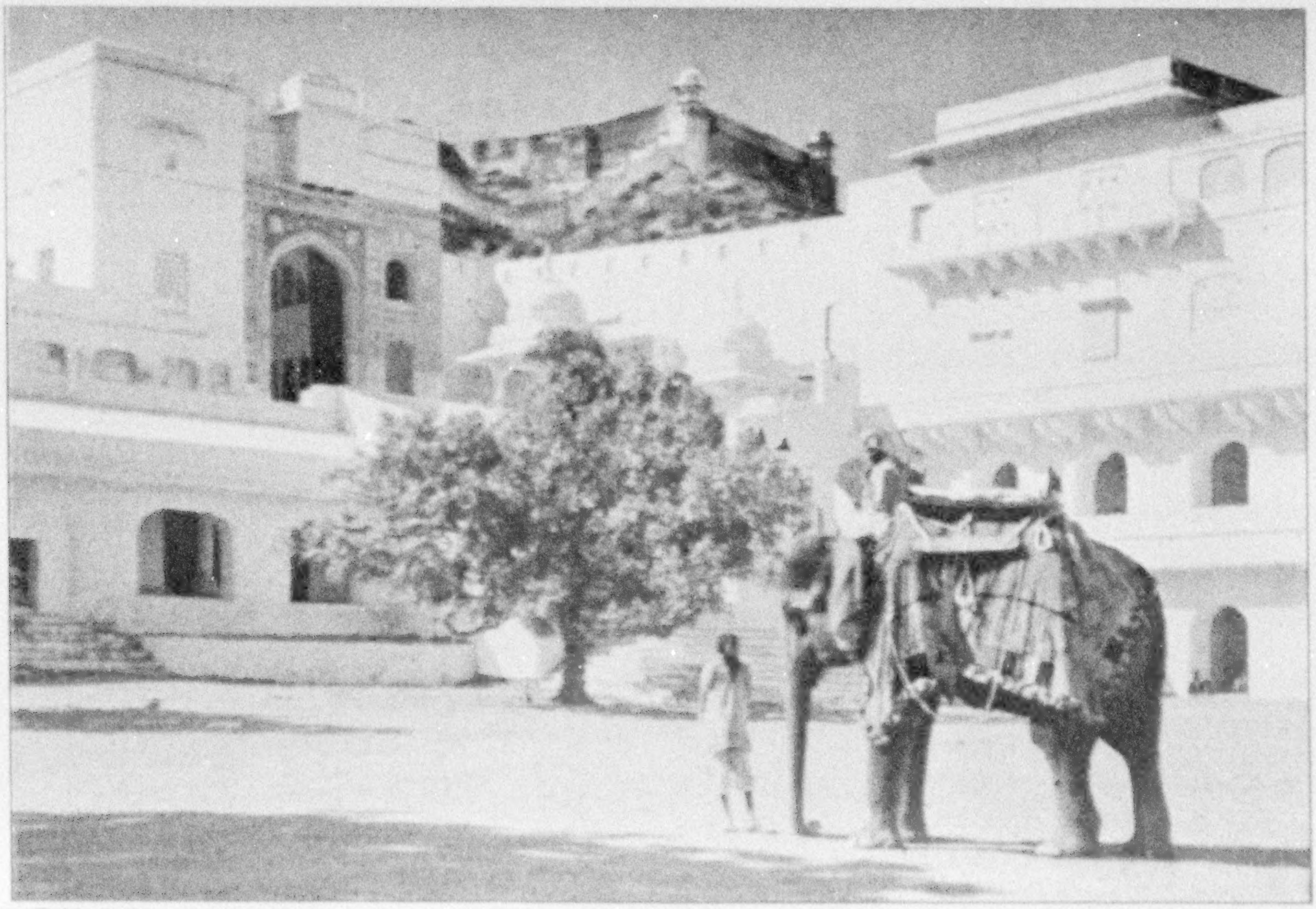
GWALIOR'S VERSION OF THE LITTLE RED SCHOOLHOUSE

The desire for education is apparently spreading faster among India's Mohammedans than among the Hindus. Nevertheless, the latter's colleges graduate more than 12,000 students a year. One progressive native ruler even defied caste to the extent of building schoolhouses for the children of the "untouchables."



A VISTA OF THE MAHARAJA'S PALACE: JAIPUR



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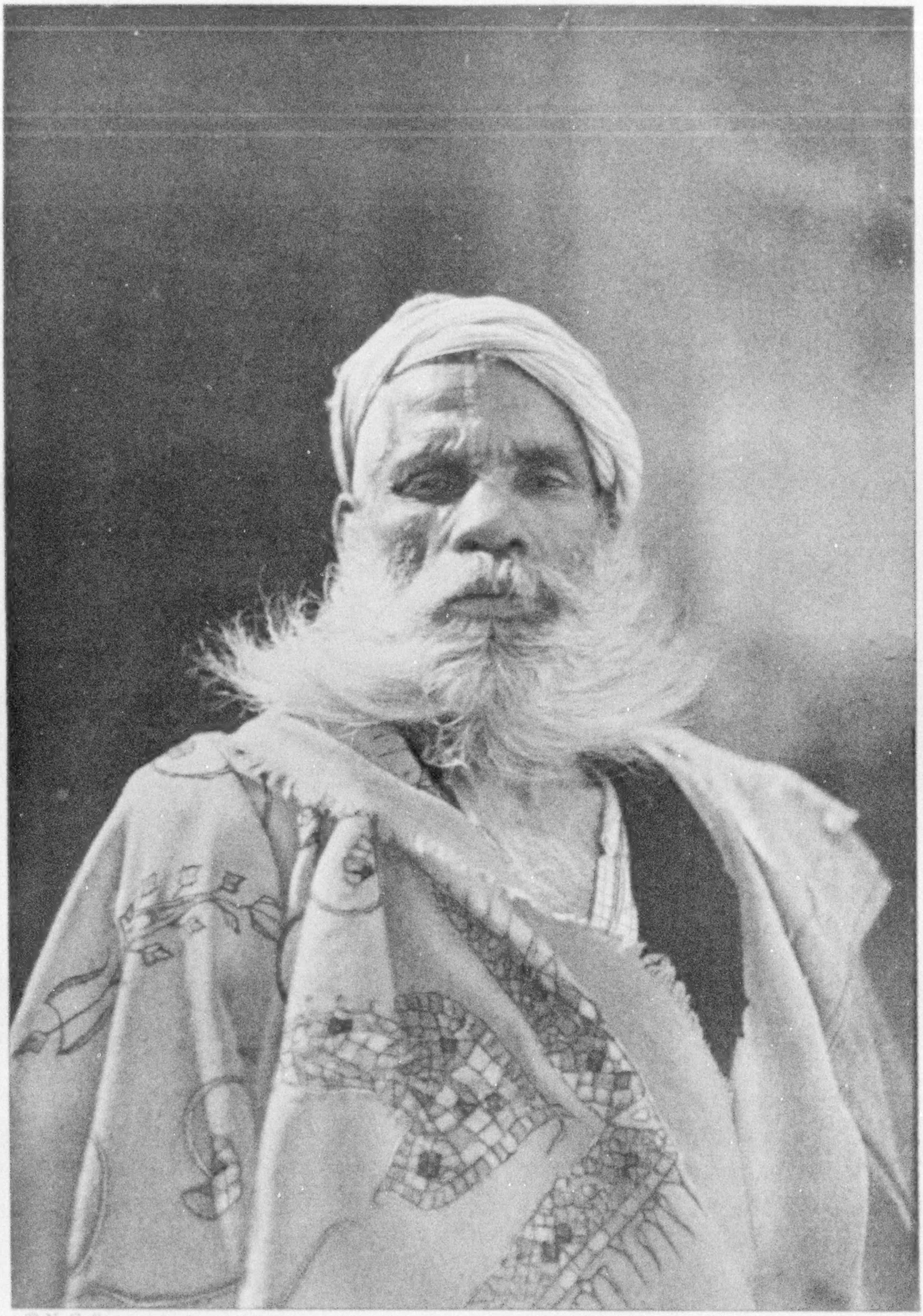
THE COURT OF HONOR IN ONE OF THE PALACES OF AKBAR

Akbar, "Guardian of Mankind," one of the greatest and wisest of the Mogul Emperors, was a contemporary of Queen Elizabeth, ruling from 1555 to 1605. He was a great builder and a munificent patron of literature, as well as a conqueror and lawgiver, and established schools for Hindus and Mohammedans throughout his kingdom.



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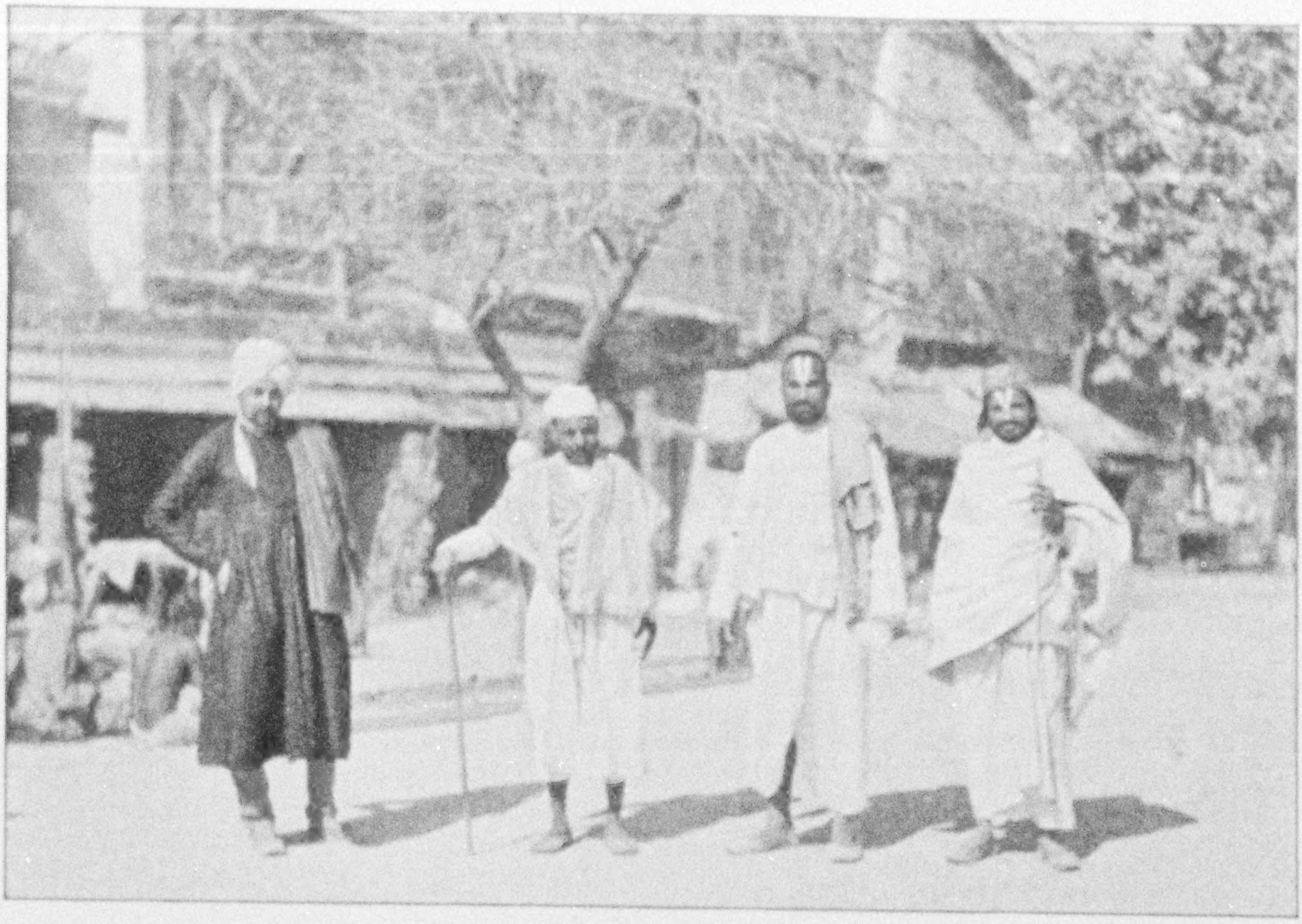
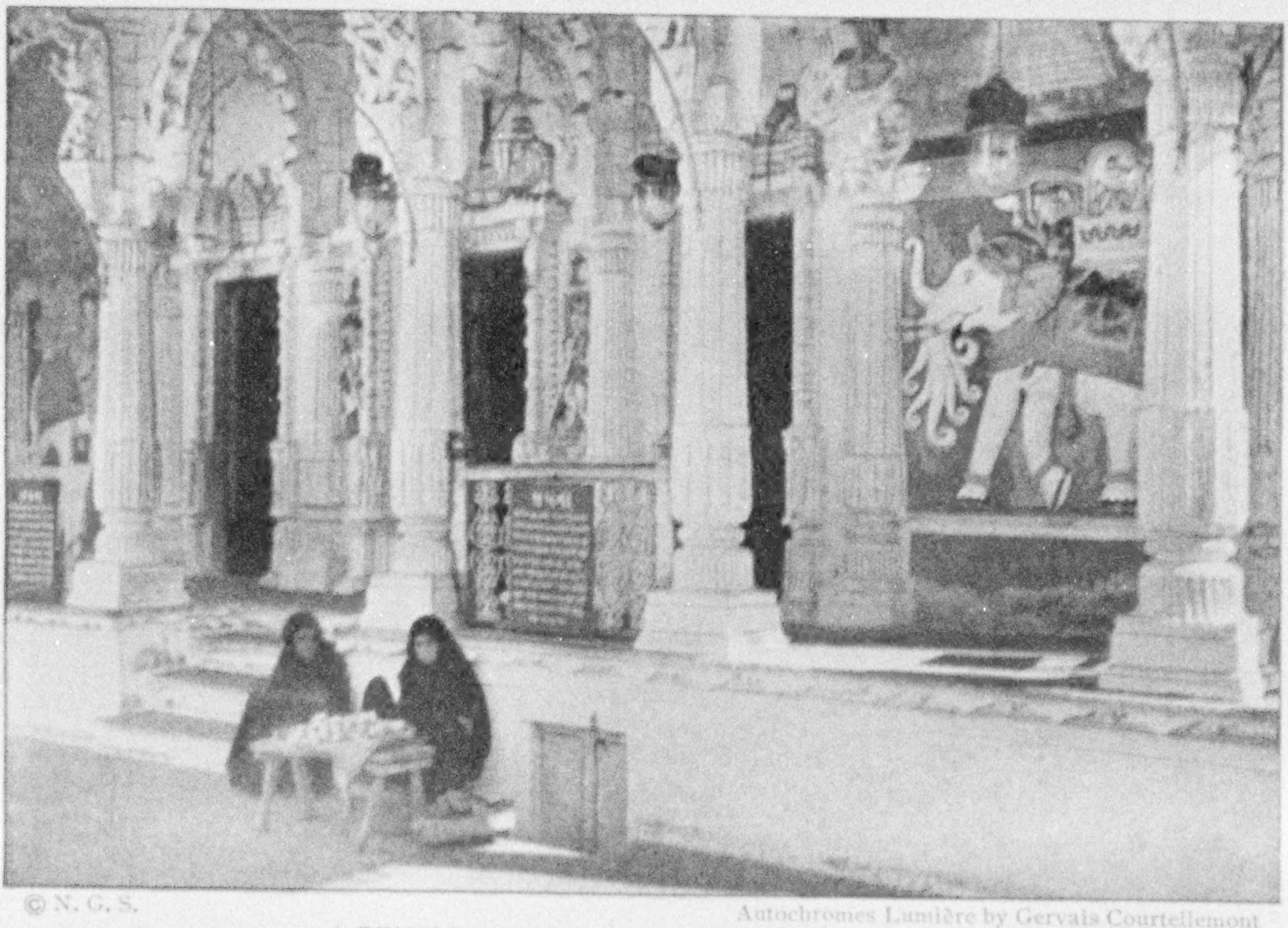
A VENERABLE RAJPUT WARRIOR OF JAIPUR

His chief source of pride is his beard, which is allowed to grow long and is parted in the middle. The two sides are brushed back and the result is a picturesque hirsute adornment that lends a peculiar expression to its wearer.



FOLLOWERS OF VISHNU, THE PRESERVER

Members of the Vishnavite sects are distinguished by the monogram of their God, which they inscribe on their foreheads.



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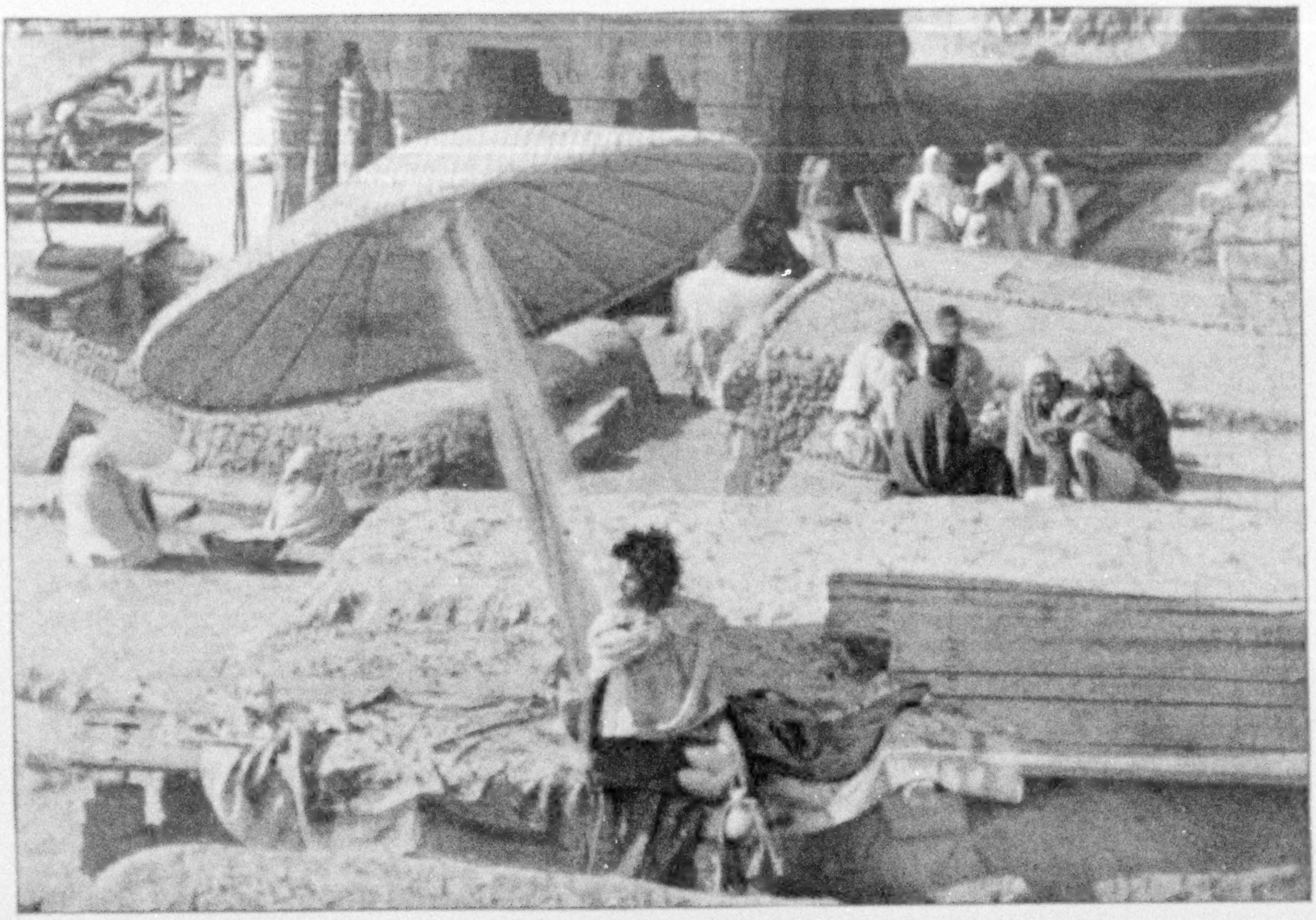
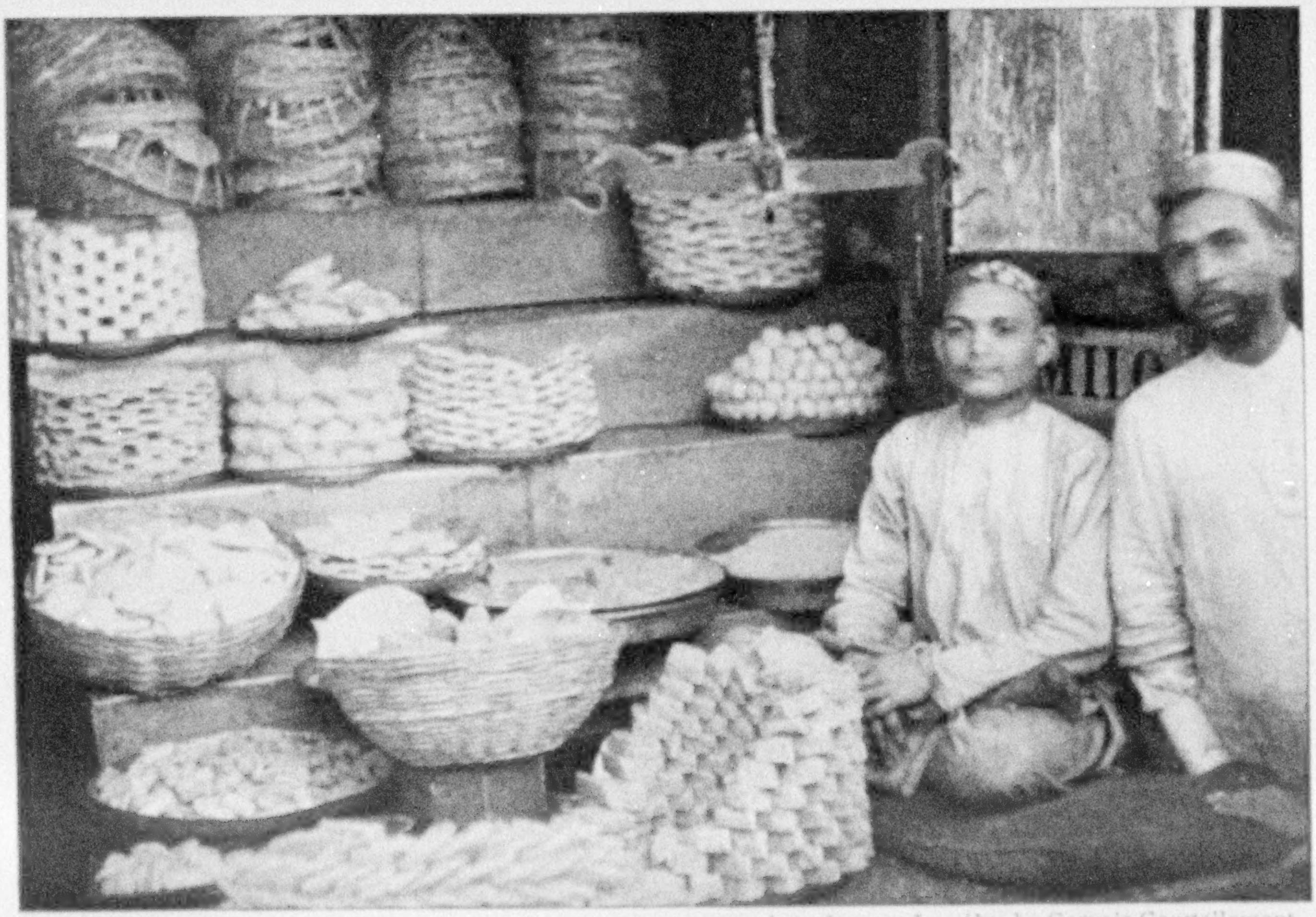
A TEMPLE OF THE JAIN SECT AT AHMADABAD

The hydra-trunked elephant, painted on the wall of the temple, is regarded as a kingly beast by more than a million adherents of Jainism in India.



A FAKIR BESIDE THE SOUL-CLEANSING GANGES: BENARES

Holy men fairly swarm to Benares, many of them torturing their bodies that they may attain greater spiritual merit. To die on the banks of the sacred river, be burned there, and have one's ashes cast into the waters is a consummation devoutly wished by them.



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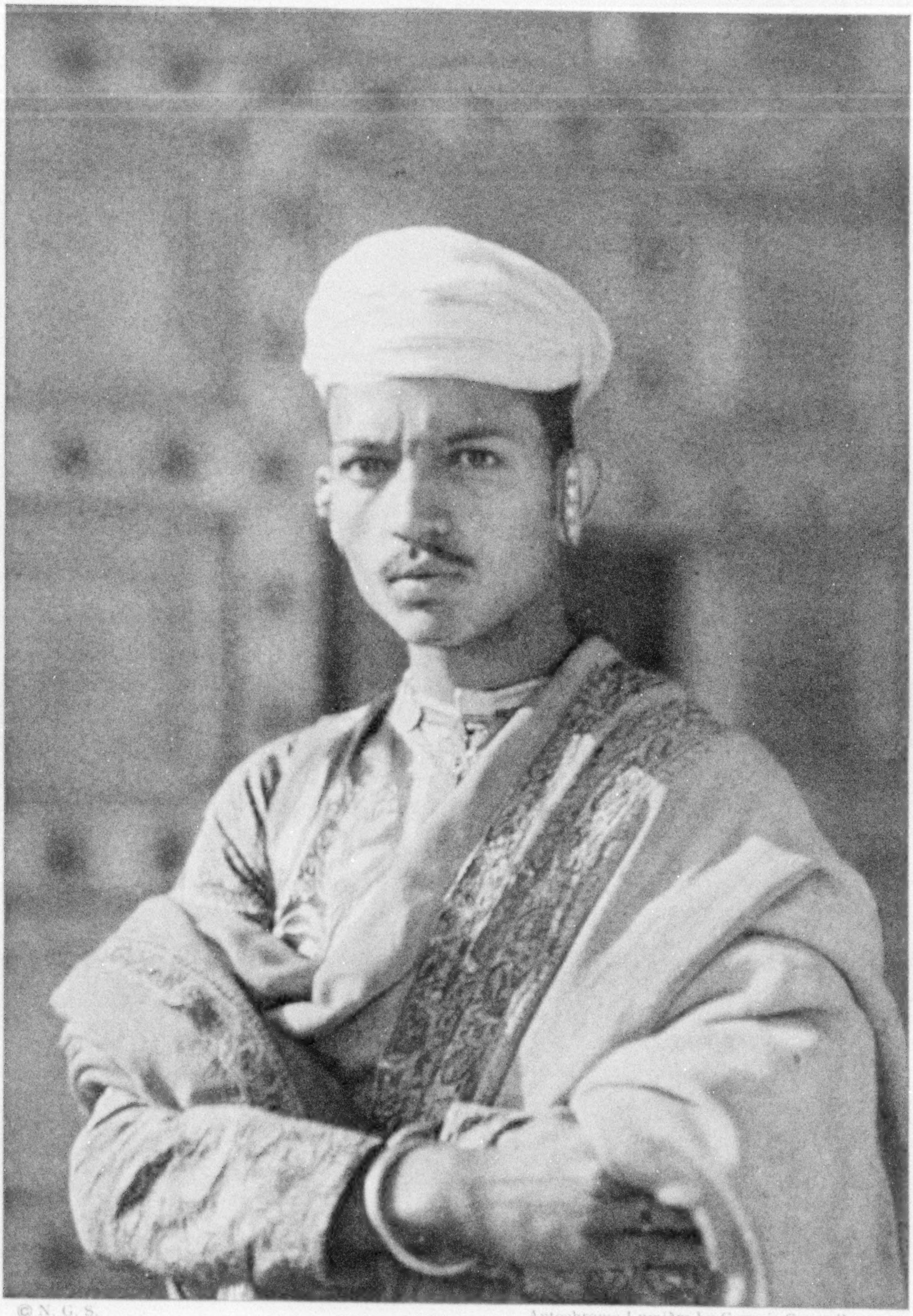
HONEYCAKES MERCHANTS OF BOMBAY

The streets of the great industrial capital of Hindustan throng with all the native races of India, and with Arabs, Malays, Europeans, and some few Chinese and Japanese.



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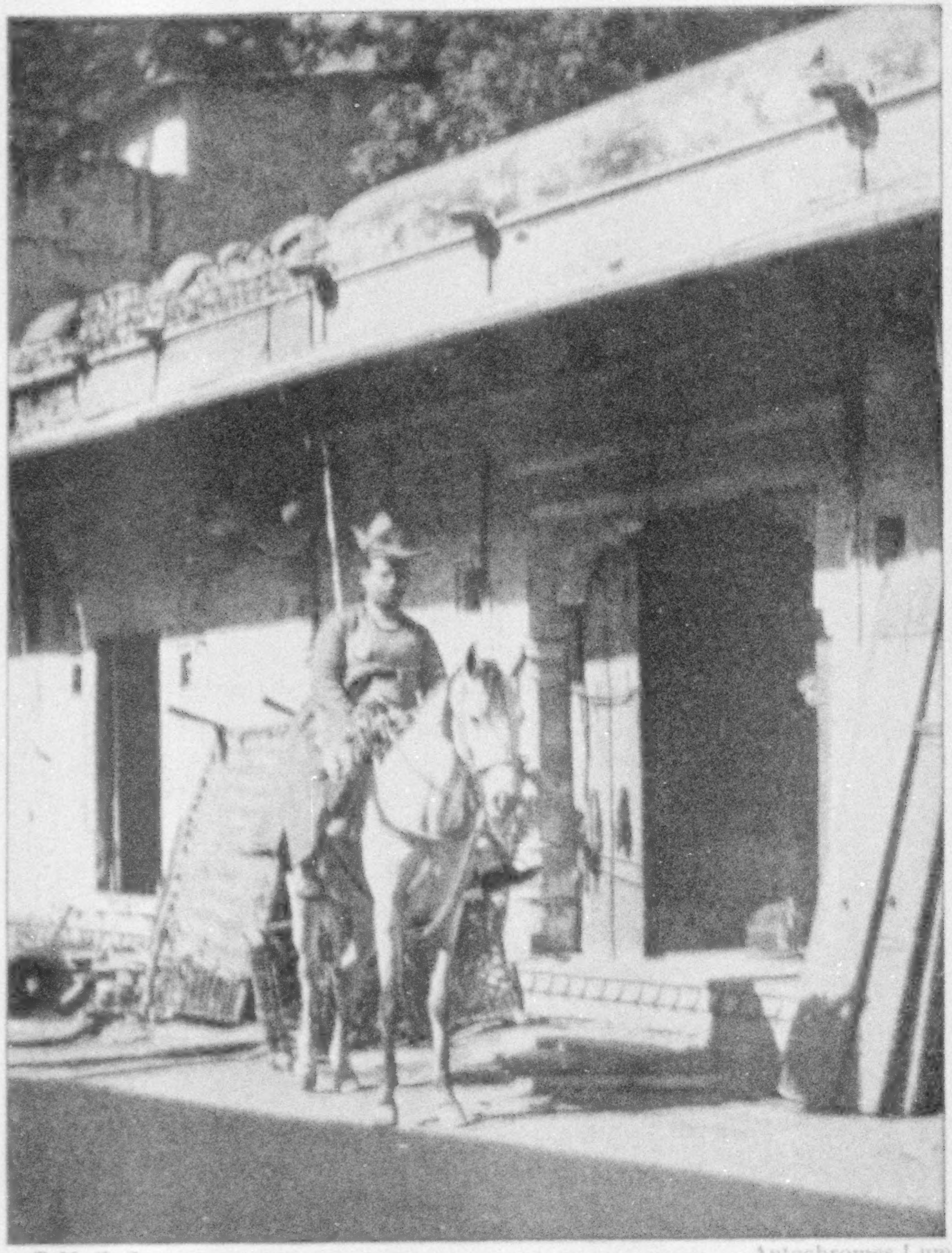
A HIGH CASTE HINDU OF JAIPUR

Caste, which developed in India side by side with Brahmanism, tends to place all Hindu social organization on a religious basis. The military class and priesthood among the Indo-Aryans deliberately raised this artificial barrier to preserve their position of supremacy over the races they conquered.



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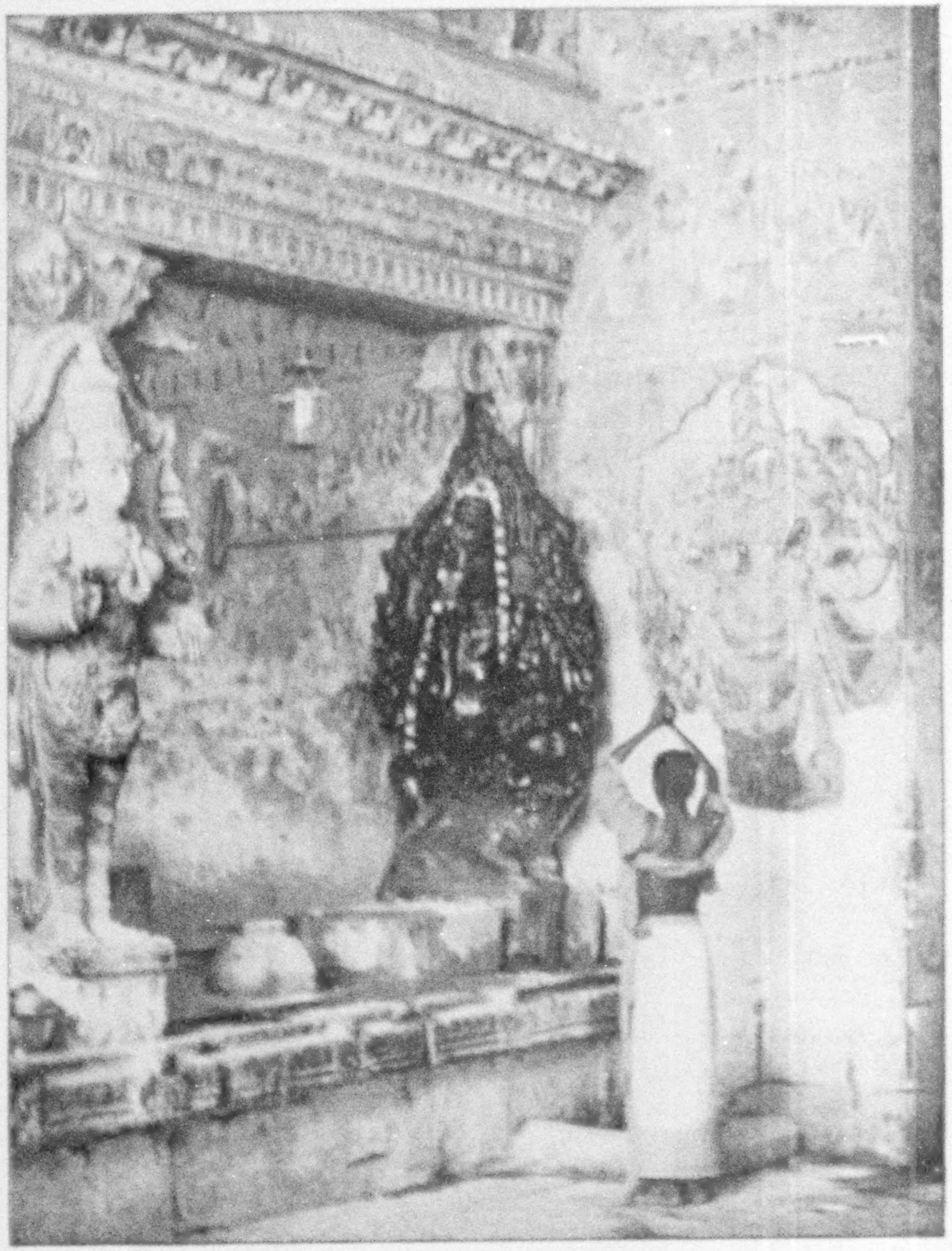
IN THE COSTUME OF THE MIDDLE AGES: GWALIOR

The old city of Gwalior is surmounted by a massive rock-girt fortress, visible for miles around. The new city near by is disdainfully termed by the Indians "Lachkar," which means "the encampment."



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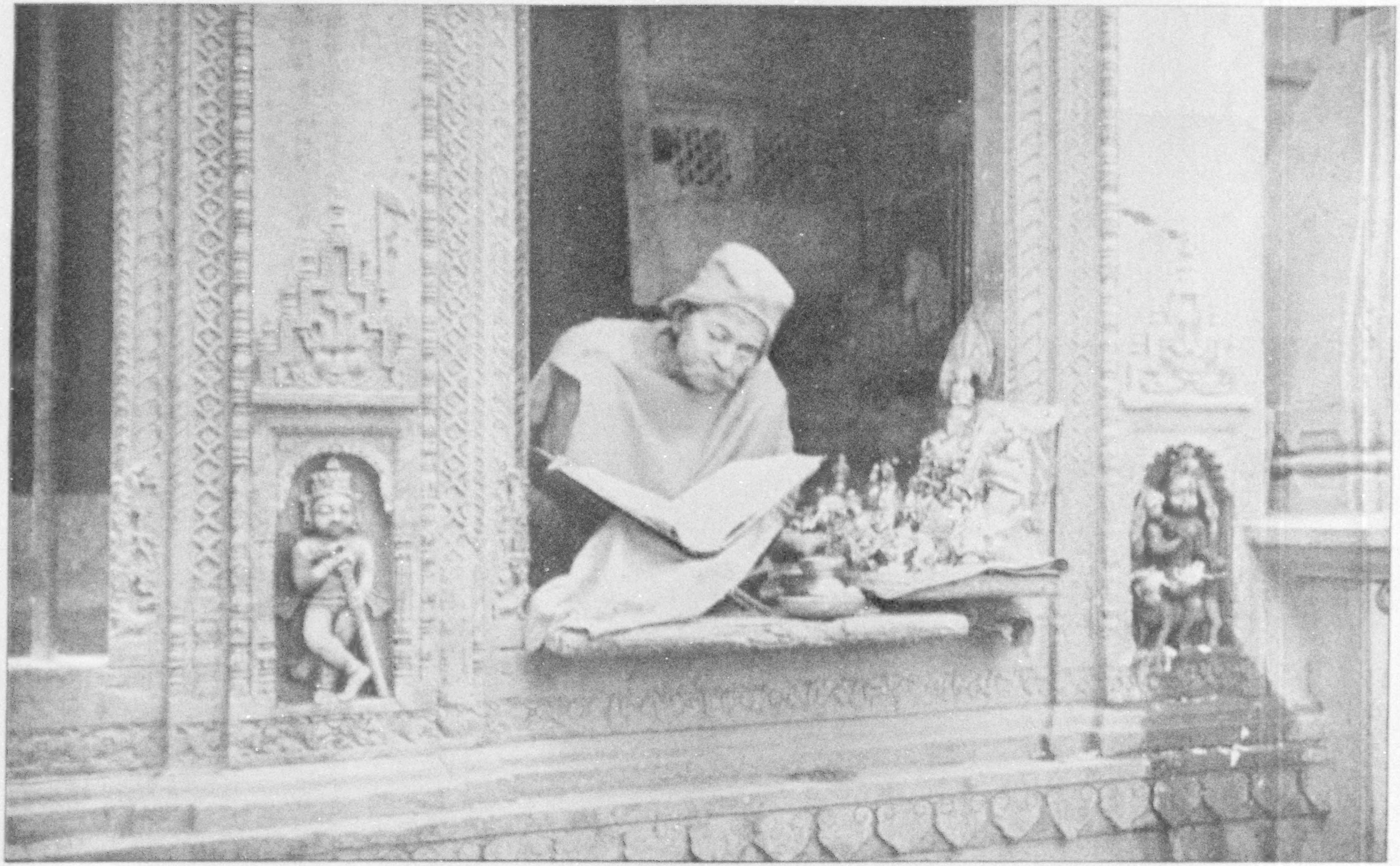
PRAYING TO GANESHA AT MADURA

The Hindu God of Common Sense and Good Luck is regarded as the protector of the household and the one to whom appeal should be made for aid in any worldly undertaking.



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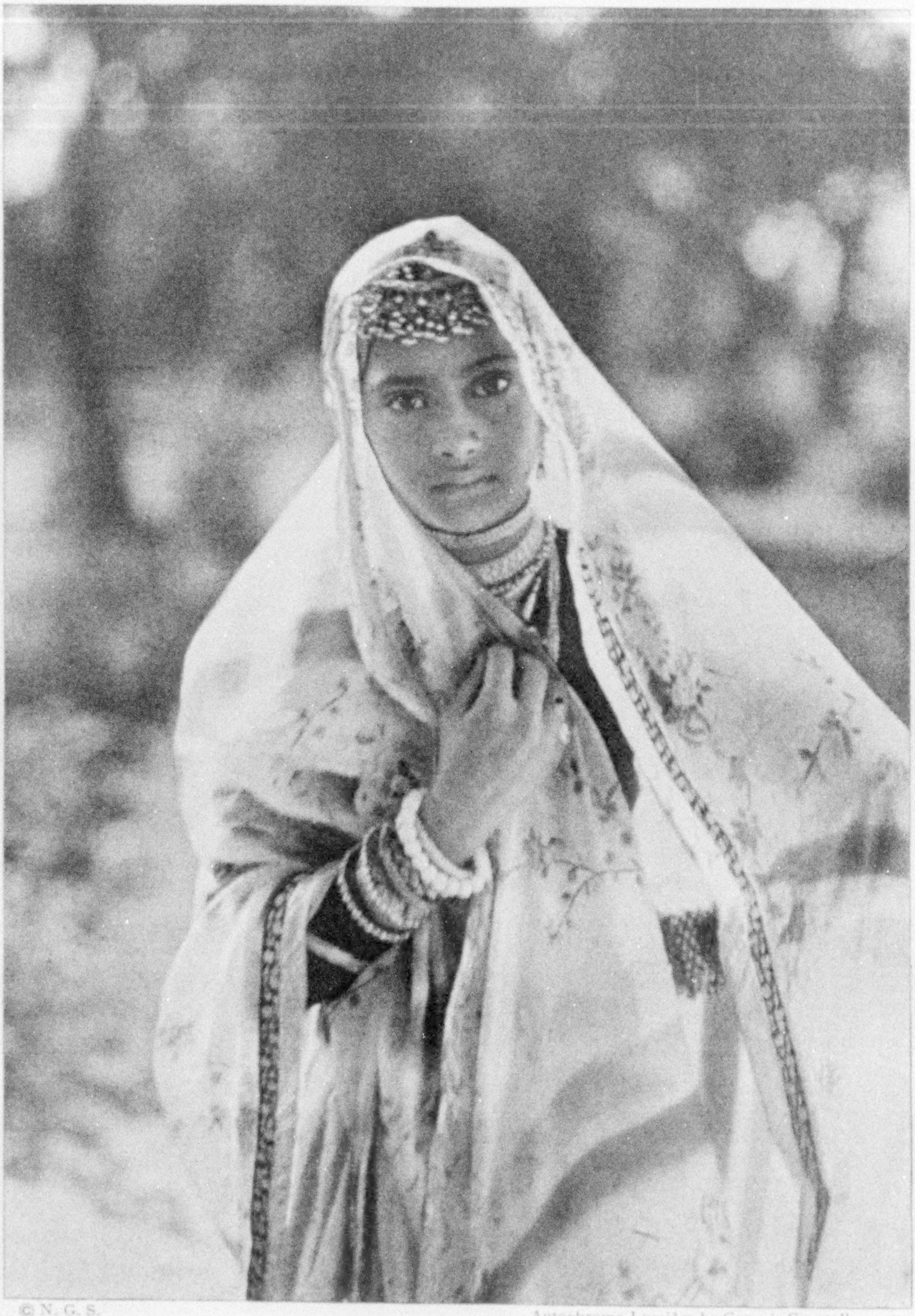
A BRAHMAN OF BENARES EXPOUNDS HIS FAITH

Four separate collections of sacred Vedic texts constitute the Hindu Scriptures and each of these has attached to it certain prose writings known as Brahmanas. All are regarded as divine revelations, upon which are based Hindu religious teachings.



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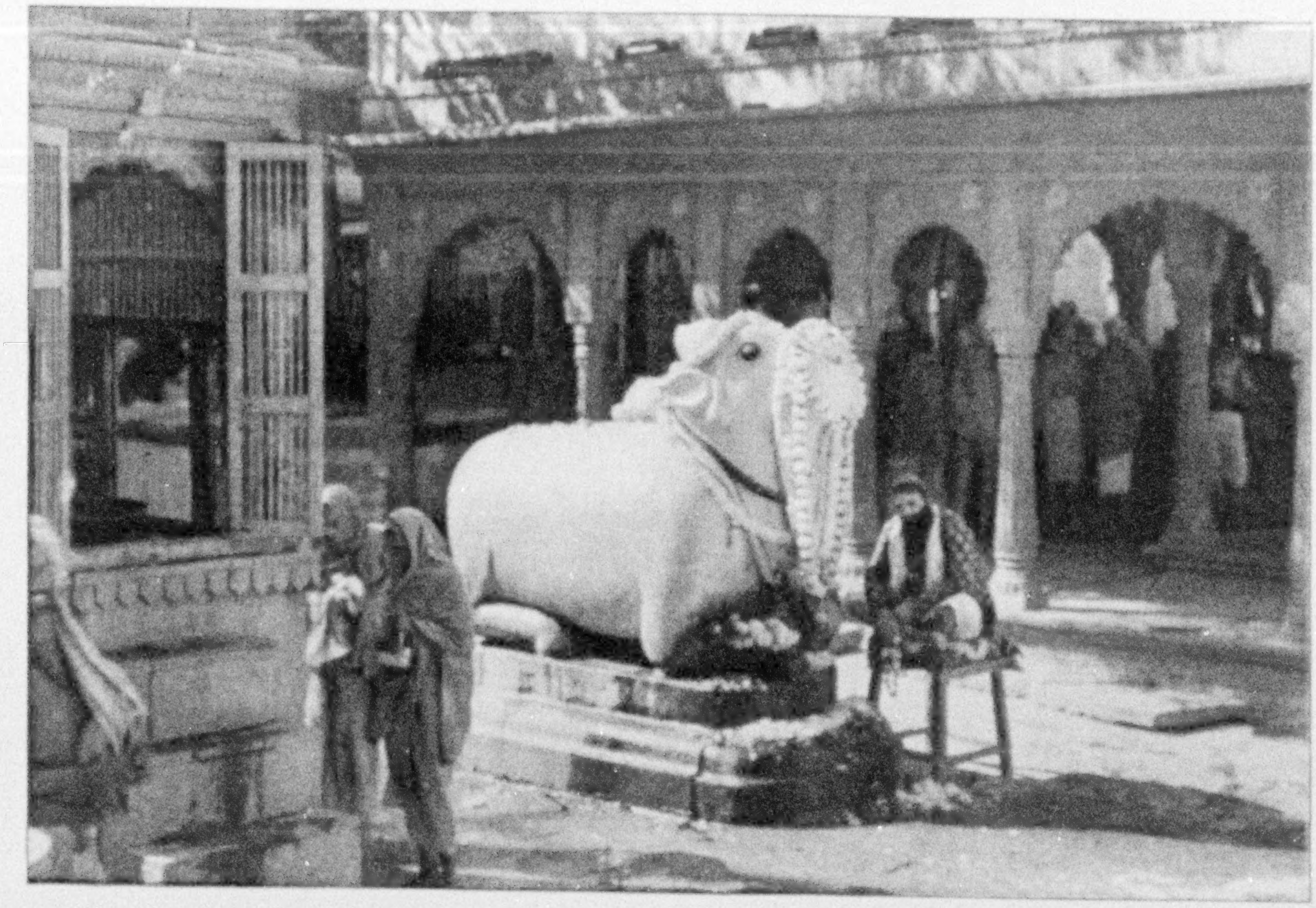
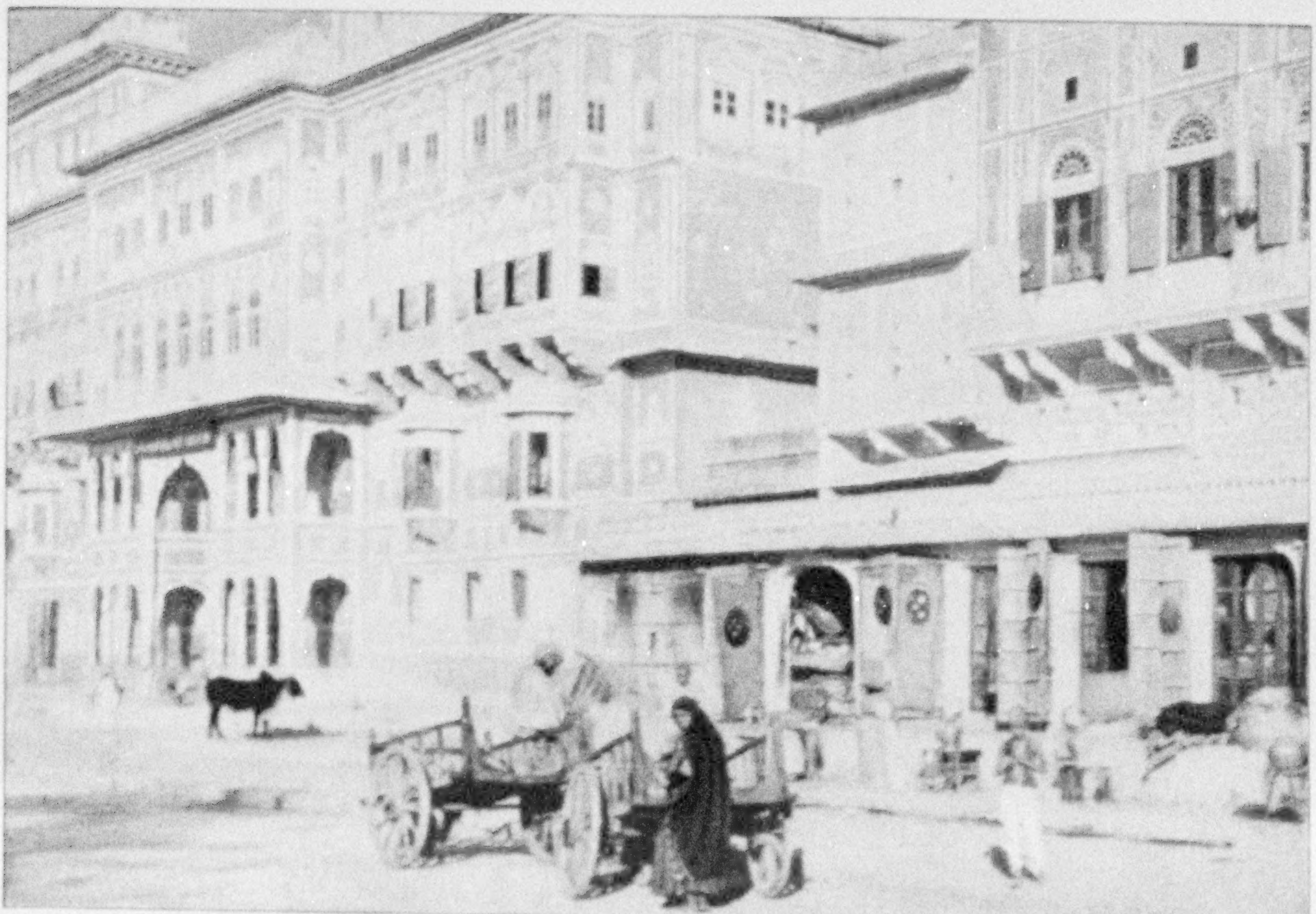
SHE DWELLS IN THE SHADOW OF THE TAJ MAHAL

The sari worn by this Hindu girl of Agra is as distinctive of India as is the kimono of Japan or the mantilla of Spain. It is usually about fifteen feet long and a yard wide. On it the ladies of India display, within the limits set by caste and fashion, their individual tastes.



THE FLOWER-DECKED IDOL IN THE COURT OF THE GOLDEN TEMPLE, BENARES

This shrine, carefully hidden in a labyrinth of narrow byways, has three domes, one of black marble and the other two of beaten gold, within which flocks of bright green parrots nest, providing a vivid color contrast.



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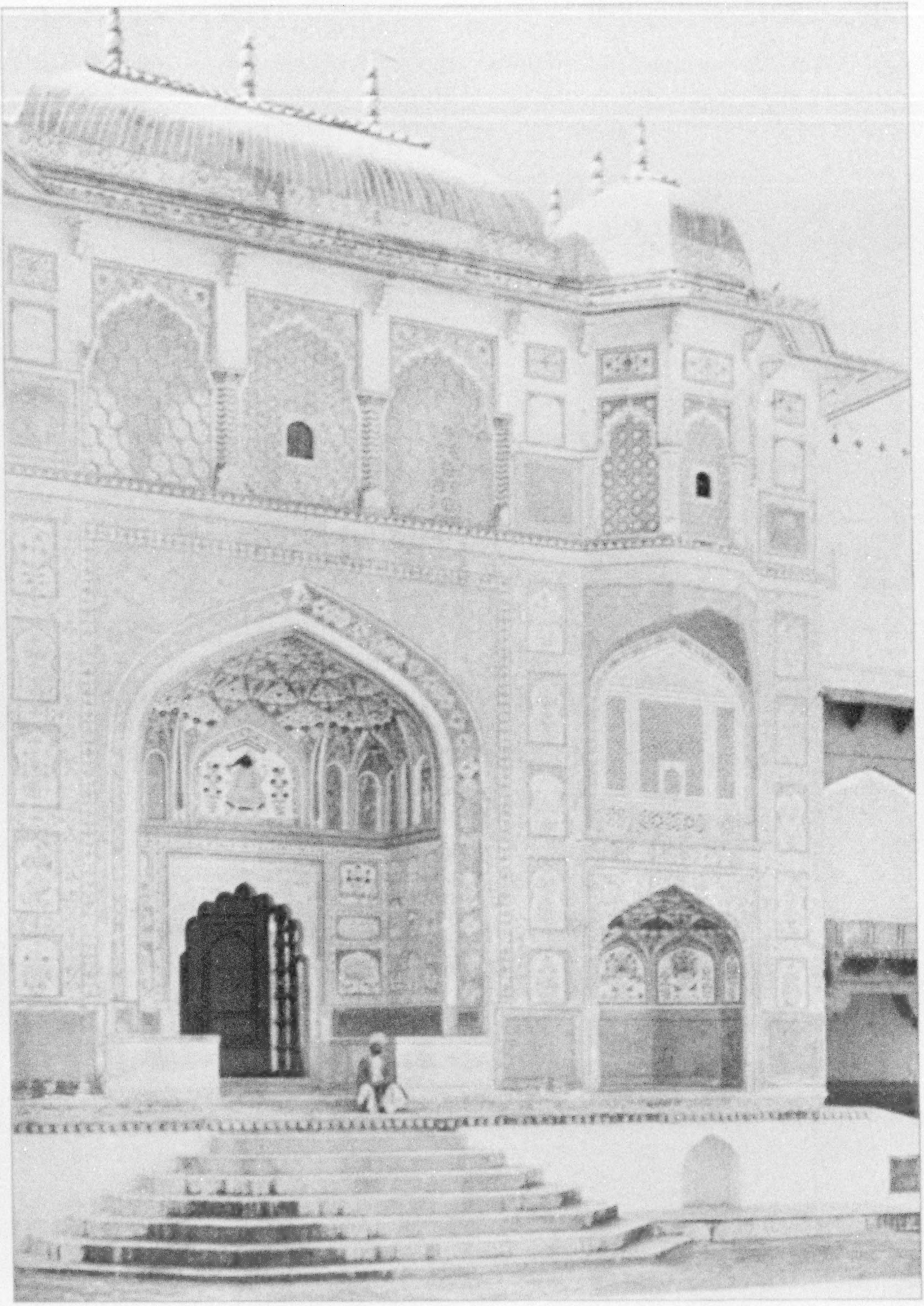
THE STREETS OF JAIPUR PROVIDE A SETTING FOR A DAILY ORIENTAL PAGEANT

Camels, bullocks, goats, donkeys, and occasional elephants mingle with men, women, and children of all classes, from miserable, naked beggars to dazzling noblemen, arrayed in cloth of gold and flashing jewels.



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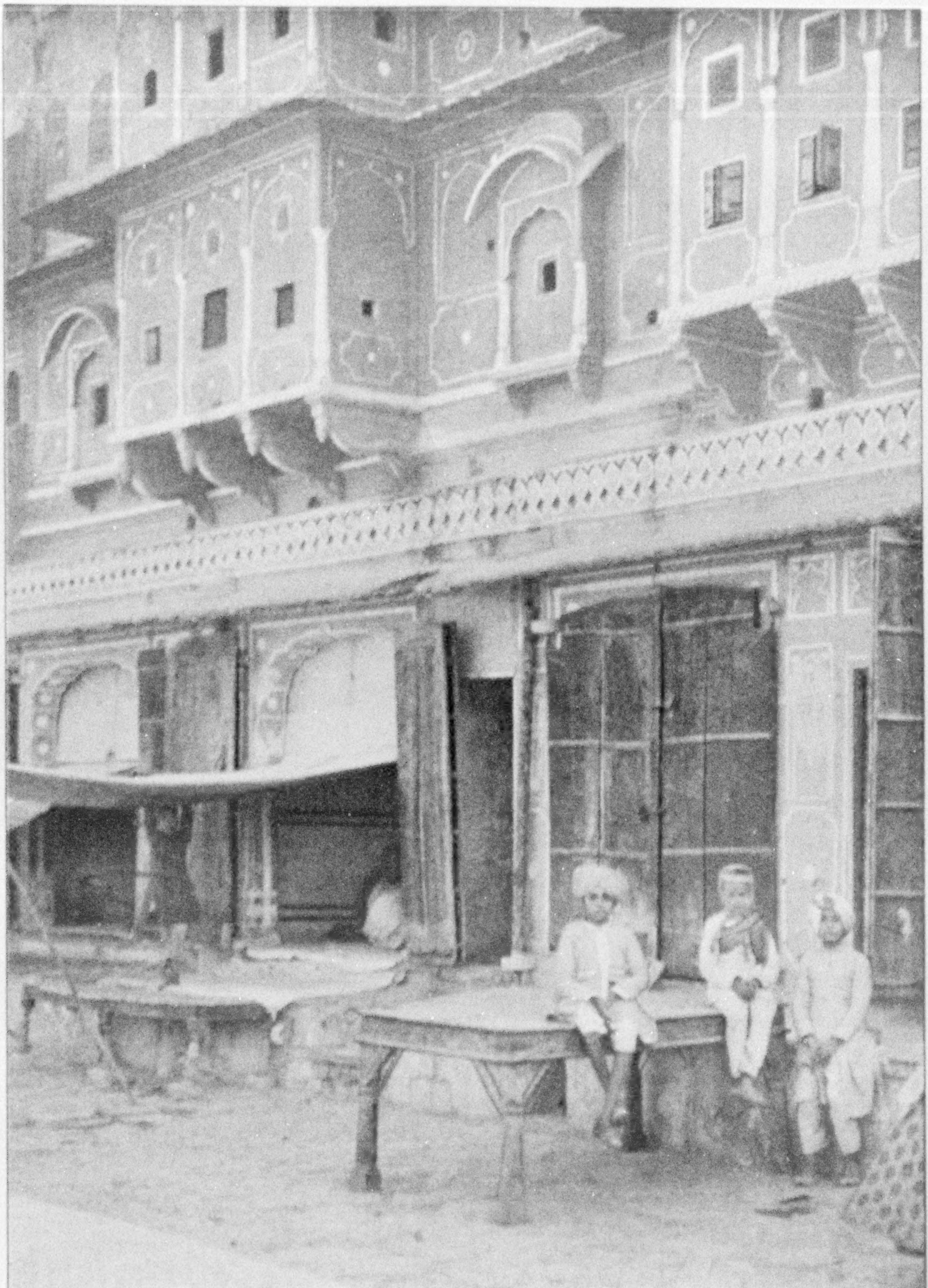
THE FAÇADE OF THE WOMEN'S PALACE NEAR JAIPUR

It is written of Emperor Akbar, who built this palace, that under him "the whole length and breadth of the land was firmly and righteously governed." He maintained a brilliant court where gathered people of every station from all parts of the known world.



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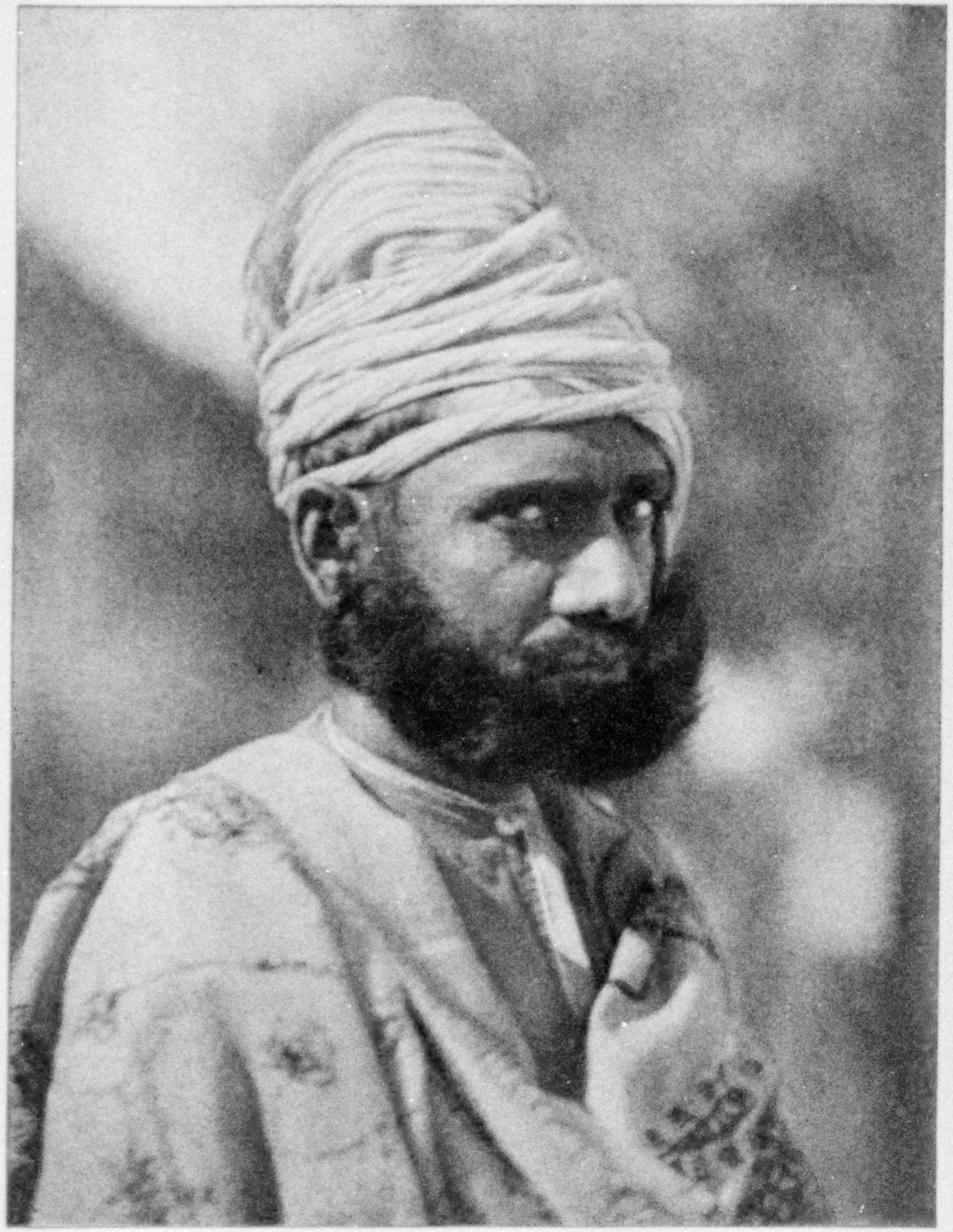
THE BAZAARS OF JAIPUR ARE NEARLY DESERTED AT MIDDAY

The noon heat drives shoppers and merchants indoors, but in the cool of the evening, when the sunset light accentuates the beauty of the rose-colored buildings, these platforms and booths are spread with wares and fabrics of many kinds.



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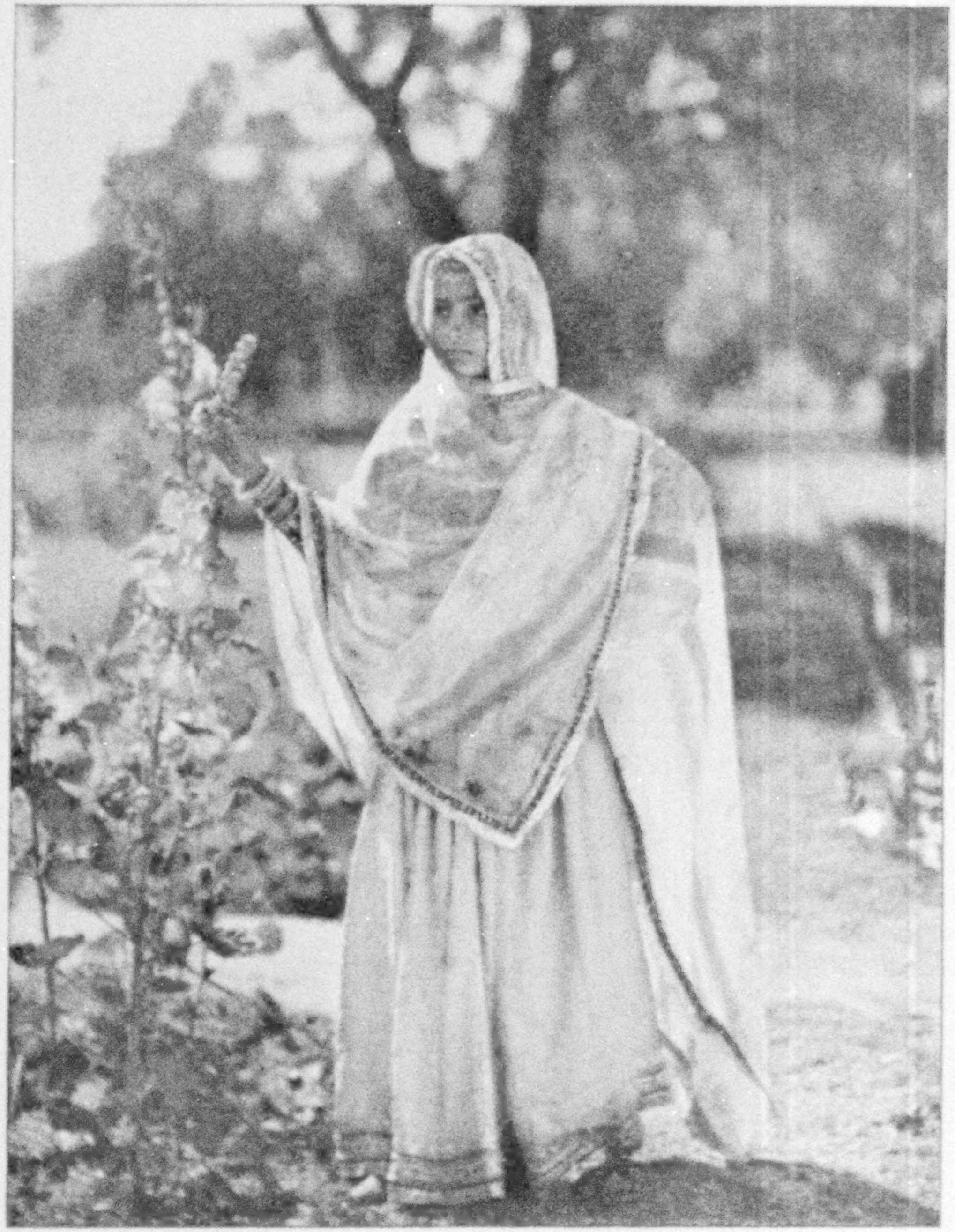
A CITIZEN OF MADURA

Although his cast of features would indicate that his forbears were among the Mohammedans who conquered India in the twelfth century, his head-dress stamps him as of Hindu faith.



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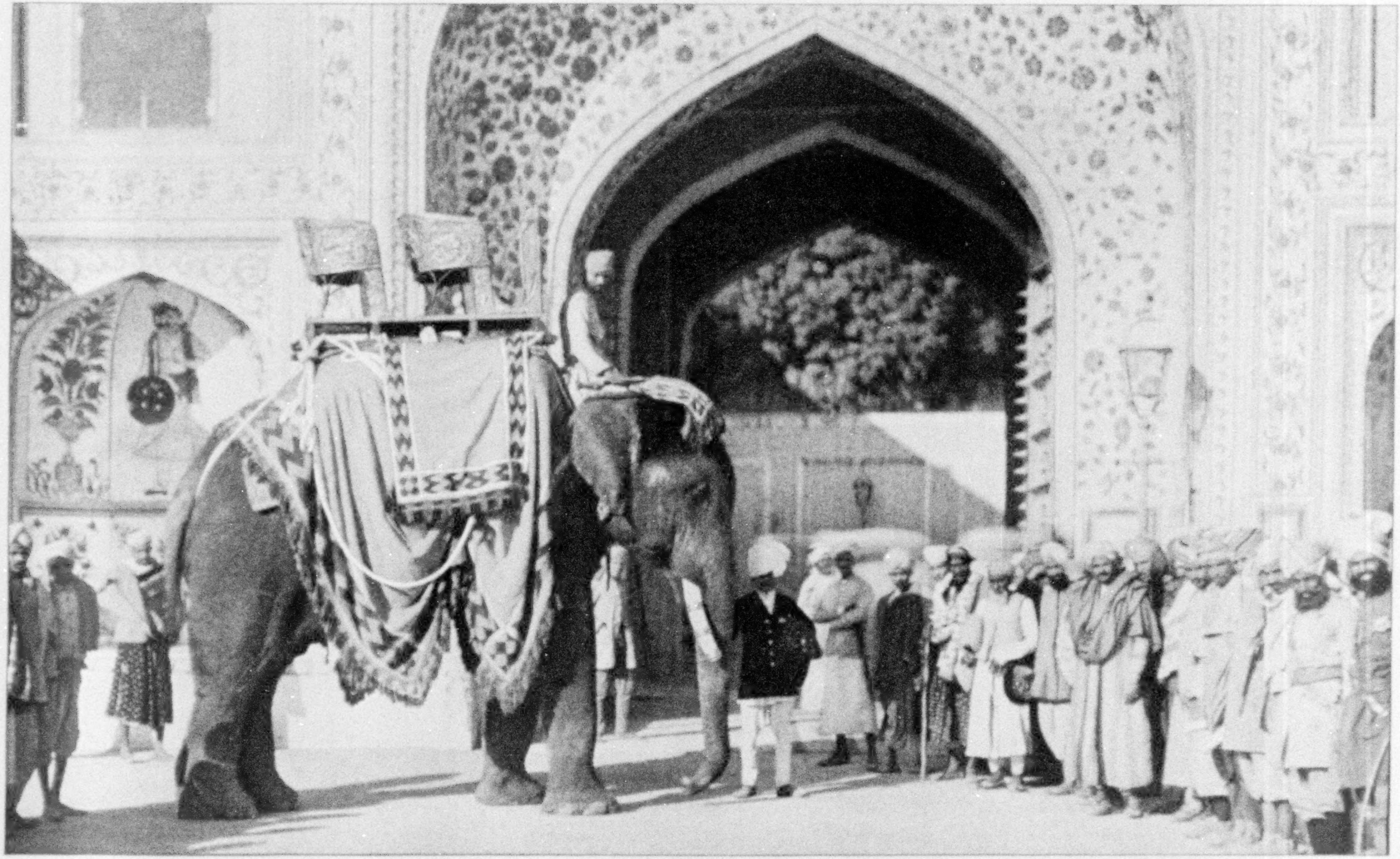
A NATIVE OF MUMTAZ-I-MAHAL'S CITY

This beautiful young Hindu girl lives at Agra, where Shah Jehan erected the world's most exquisite structure, the Taj Mahal, in memory of his wife.



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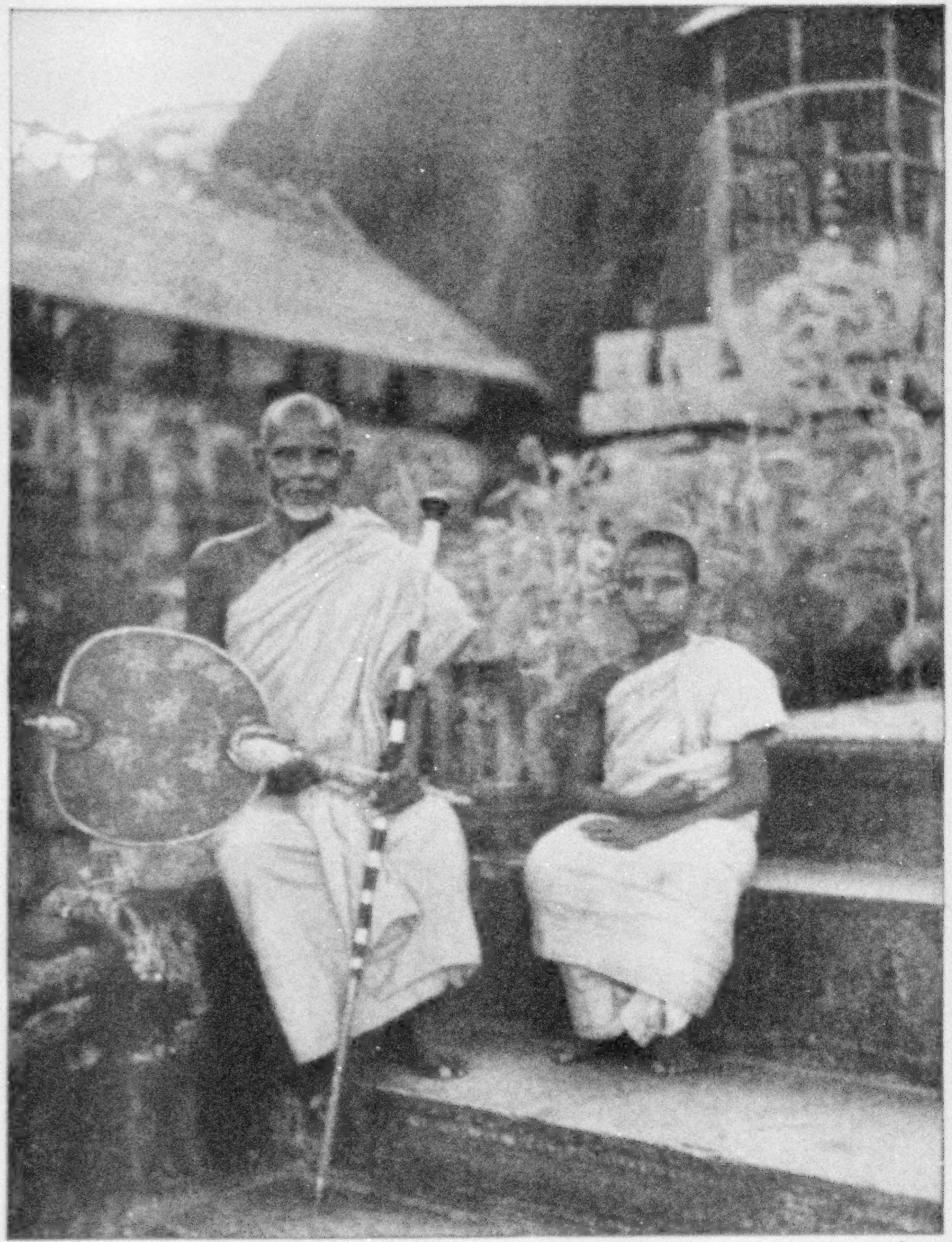
A STATE ELEPHANT IN THE RETINUE OF THE MAHARAJA OF JAIPUR

These great beasts have played a prominent part in the life and history of the people of India, but for passenger travel the speed and smoothness of the motor car is coming to be more desired. The Maharaja of Jaipur is a progressive prince and he has spent freely of his vast wealth to improve conditions in his state.



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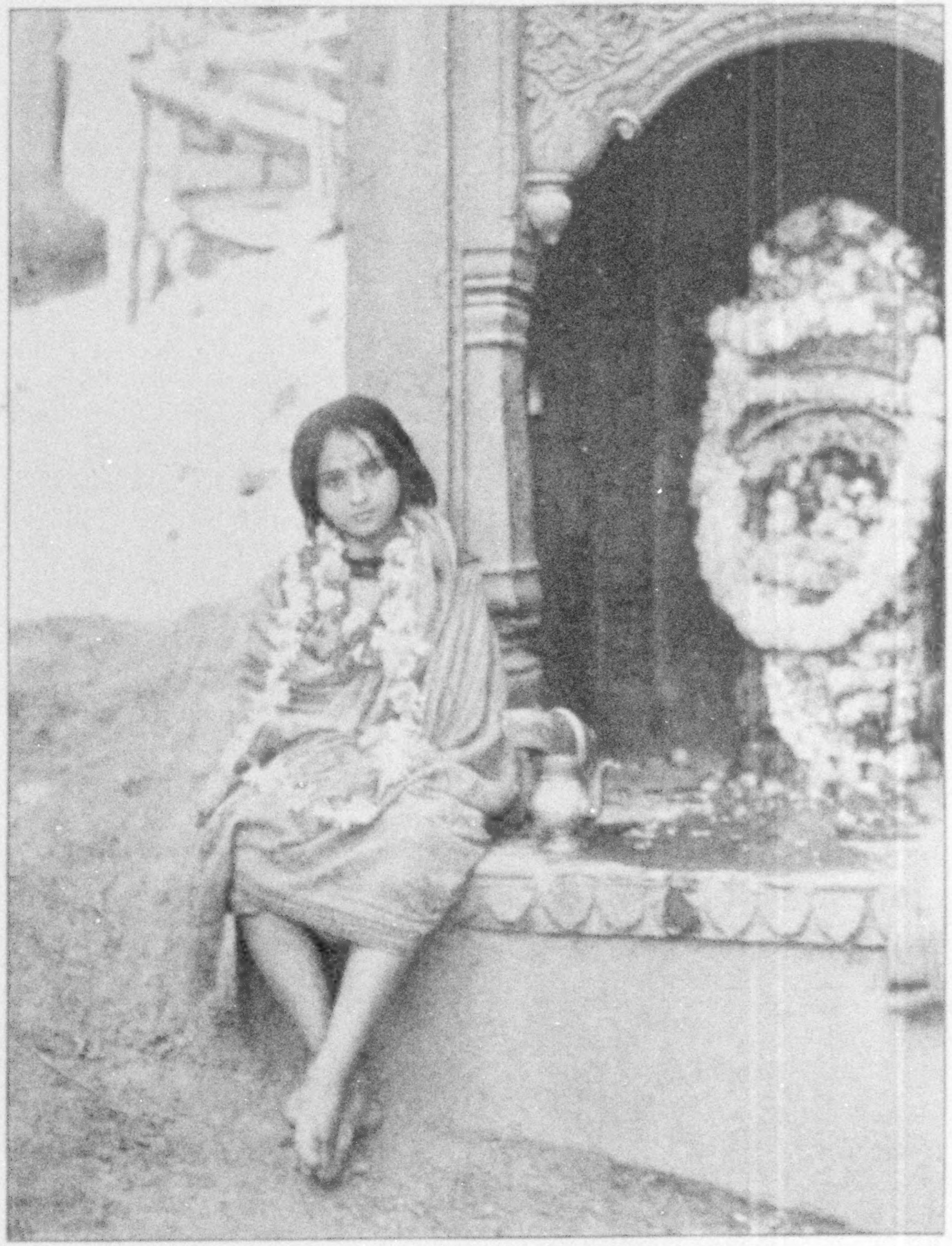
A SINGHALESE PRIEST AND HIS ACOLYTE

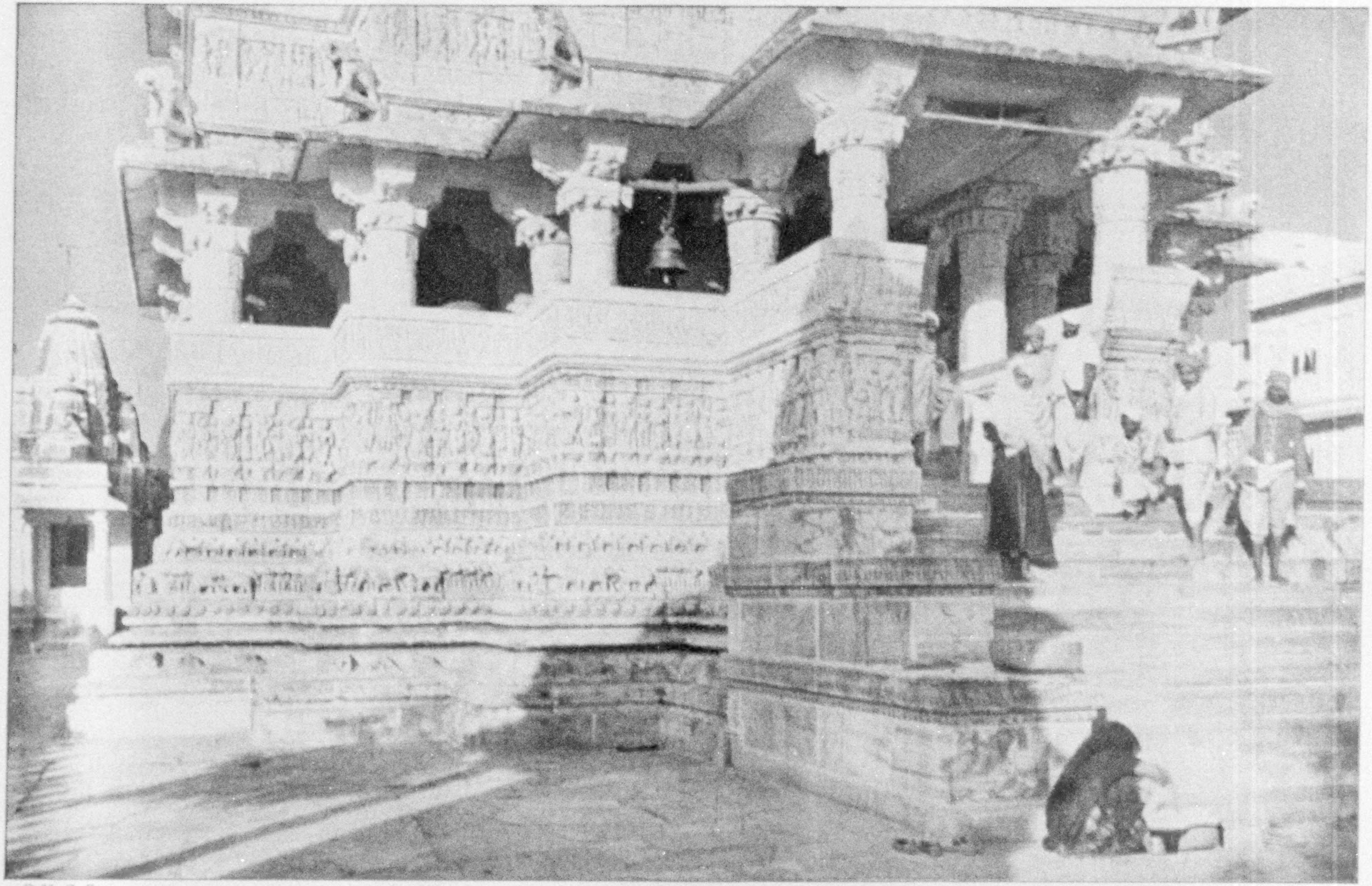
There are many Buddhist priests in Ceylon and nearly all of them adopt this style of dress. Boys begin to study for the priesthood at an early age.

Autochromes Lumière by Gervais Courtellemont



AN ARISTOCRATIC YOUNG MENDICANT OF BENARES

This young Brahman beggar's calling hardly befits the exalted claims of the caste which terms its members "Gods of the Earth."



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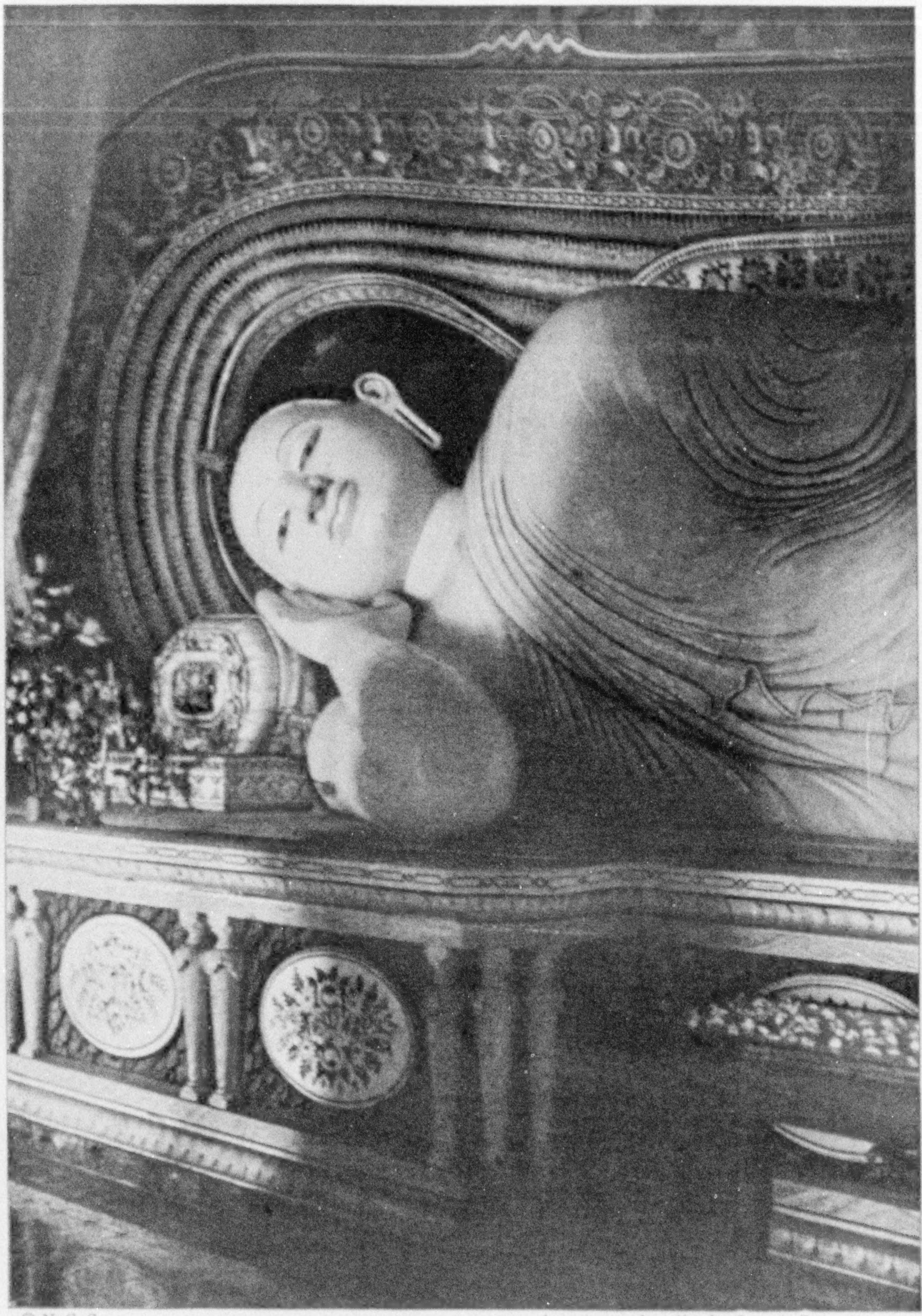
A BRAHMAN TEMPLE OF UDAIPUR

There are several Brahman temples in Udaipur, whose ruler was designated as personal aide-de-camp to King George V when that monarch came to Delhi to be crowned Emperor of India, because he (the Maharana) would not ride anywhere save at the head of the procession of princes, a place reserved for the Nizam of Hyderabad. As aide-de-camp he stood in attendance on the Emperor while the other potentates rode by.



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NIRVANA ATTAINED

This colossal image represents the great Buddha in that blissful state in which the Buddhist believes the soul ceases its transmigrations and is absorbed into the divine.

advancing tide of industrialism. But Ahmadabad's beauty has not been destroyed; it is still one of India's finest examples of a combination of Mohammedan strength and Jain delicacy in architecture (see Color Plate XI).

The Jains, of whom there are many in Ahmadabad, are an interesting people. One of their principal religious tenets is kindness to animals and a very high regard for all kinds of life. Legend has it that the last of the Jain kings lost his kingdom by refusing to march his army on a rainy night because of the enormous number of insects that would surely perish under the feet of his soldiers.

Jain architecture is distinctive for its lightness and grace, and no other people have ever come so near to making lace out of marble. In many parts of India temples of exquisite design and even more exquisite workmanship stand as memorials to the wealth, artistic skill, and religious devotion of this sect.

MARBLE PAVILIONS FOR A PINING BRIDE

The picturesque old city of Udaipur is distinguished in having as the head of its ruling house the bluest blue-blood in India. This prince claims direct descent from the Sun God (see Color Plate VI).

The royal palace at Udaipur is an imposing mass of marble and granite occupying a magnificent site on the shores of a beautiful lake. On the clear waters of this lake there seems to float an island decked with marble pavilions half hid in greenery—a dream of pearl and emerald in the midst of a great sapphire. An ancient king of Udaipur is credited with having built up this island and its pavilions for his bride, that she might worship there as she had in her father's house.

In the court of the Maharana's palace are several arches, under which it was once the wont of the haughty rulers of Udaipur to have themselves weighed, using bags of gold and silver as a balance and then distributing the coins as largess among their subjects.

The Rose City of Jaipur (see Color Plates III, IX, XVII, XIX, and XXI) is comparatively new, as time is reckoned in India, having been founded less than two centuries ago. It is a well-planned, well-governed city, but the crenellated masonry walls which surround it are reminiscent of times when the native states were engaged in almost constant warfare.

In all of these cities the gods of Hinduism occupy a prominent place. These deities are so numerous that they defy classification, but the great triumvirate are Brahma, the Disposer; Vishnu, the Preserver, and Siva, the Destroyer.

To these might be added a fourth, Ganesha, whose image is to be found everywhere—in temples, in homes, and even by the roadside. He is regarded as the deity of common sense, and it is to him that supplication must be made before undertaking anything of a serious or important nature (see Color Plate XIV).

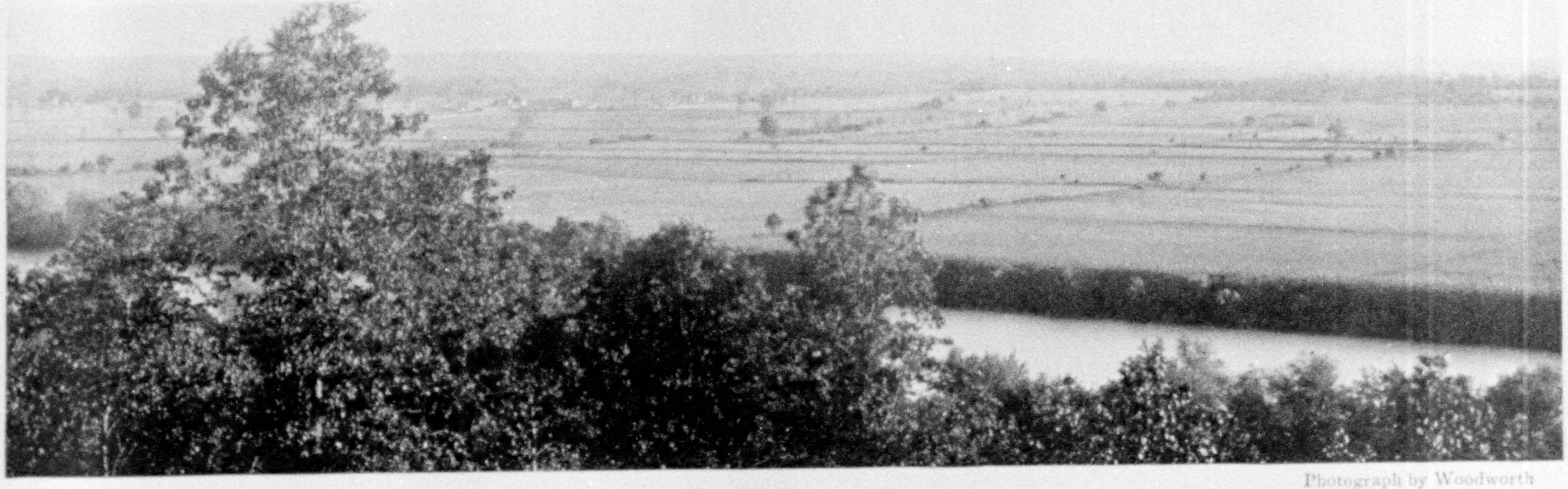
This god is supposed to be a son of Siva and Durga and is represented as a hideous creature, with an elephant's head and an enormous infant's body. The following explanation is given for the monstrosity:

When Ganesha's mother first saw him her gaze was so brilliant that it burnt off his head. Siva was quite disturbed at the idea of having a son without a head, and in an effort to remedy the difficulty sent out servants with orders to bring him the head of the first living creature they encountered sleeping with its face toward the north. This happened to be an elephant, whose head was duly cut off, brought to Siva, and fastened by him to his son's neck. The elephant's head is also symbolic of the wisdom attributed to this strange divinity.

While a considerable feeling of jealousy and even hostility sometimes develops between the followers of Vishnu and those of Siva, in general the Hindus are liberal-minded and it is not unusual for a man to belong to several religious cults, and he may change about at will.

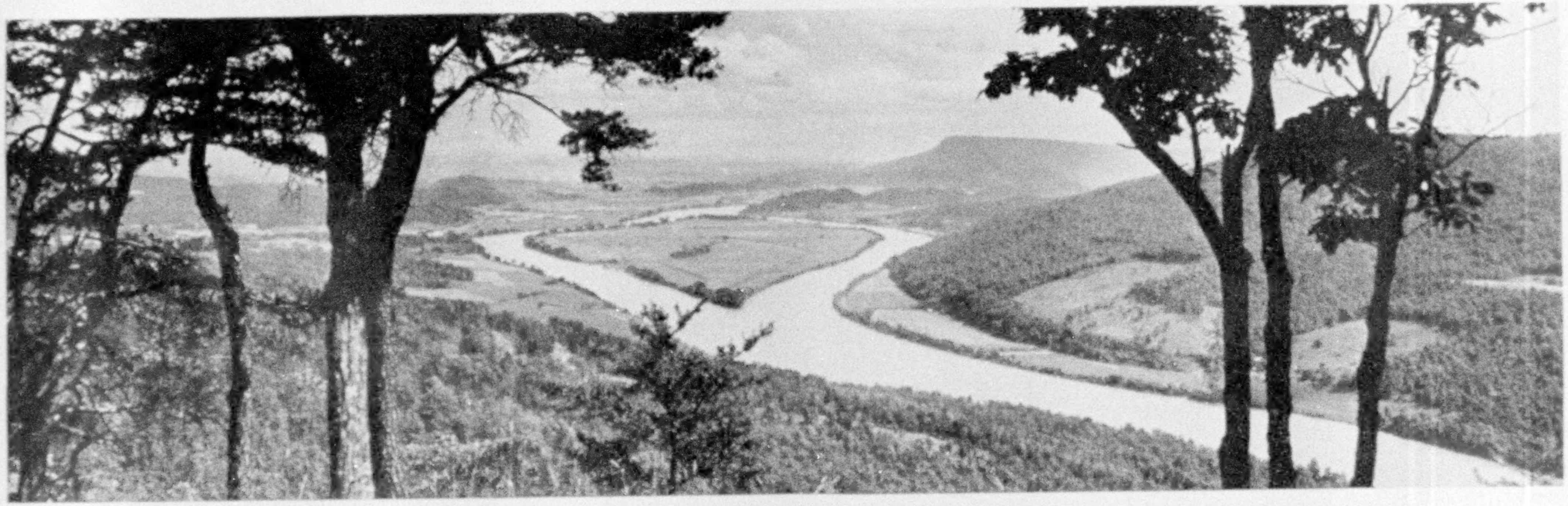
This freedom to change from one god to another does not extend to the lines of caste, however, and the Brahmans guard their high position jealously, clinging with extreme tenacity to long-established customs.

Caste-ridden, infested with strange deities, burdened with poverty, India nevertheless allures with its mystery and its occasional scenes of surpassing beauty; and always there is color, intensifying the high lights, brightening the shadows, and weaving its spell over all the drab and sordid elements of life.



Photograph by Woodworth

WHERE THE JAMES RIVER HAS BUILT UP ONE OF THE WORLD'S FINEST EXAMPLES OF A FLOODPLAIN OUT OF THE TREASURES GATHERED IN THE MOUNTAINS (SEE TEXT, PAGE 93)



THE TENNESSEE RIVER, WITH RACCOON AND LOOKOUT MOUNTAINS AT THE RIGHT, AND WILLIAMS ISLAND AS SEEN FROM SIGNAL MOUNTAIN, NEAR CHATTANOOGA, TENNESSEE

PIRATE RIVERS AND THEIR PRIZES

The Warfare of Waterways Has Sometimes Changed the Geography of Our Continents

By John Oliver La Gorce

Author of "Porto Rico, the Gate of Riches," "Pennsylvania, the Industrial Titan of America," "The Warfare on Our Eastern Coast," "A Battle-Ground of Nature," "The Fight at the Timber-line," etc., in the National Geographic Magazine

NOTHING seems more permanent to most of us than the rivers, the rocks, and the hills of the earth. The casual observer has, perhaps, seen a stream change a short stretch of its channel during a period of unusually high water; he doubtless has stood at the foot of a cliff and noticed the accumulated débris there; and likewise has observed a landslide or a forming gully in the mountains. Yet to him, as the old poem tells in song, the brook "goes on forever," the rocks are "eternal," and the hills are "everlasting."

But the lives of rivers and rocks and mountains cover no greater span in geological time than do human lives in the history of mankind. Their vicissitudes are as many, their relationships as intricate, and their tenure of existence as short in terms of geological epochs as are ours by the yardstick of changing human events.

Measured by the life of the earth, rivers and rocks and mountains, like man himself, "bring their days to an end as a tale that is told."

The biographies of rivers form life stories of fascinating interest. The wars they wage, the campaigns they fight, the munitions they employ, the victories they win, the defeats they suffer, and the scarred battlefields they leave behind them, make their struggles against Nature and among themselves closely parallel the often warlike course of human affairs.

The streams have their lusty youth, flowing down steep grades with dashing, noisy, care-free abandon; their adolescence, taking on the more circumspect characteristics of grown-up waterways; their maturity, in which they settle down to a quieter, more rotund existence; their rejuvenation, in which they seem to stage a return to youth; and their old age, in which they become feeble-flowing, erosionless liquid highways, no longer able to share in the hurly-burly of stream activity.

MEASURING THE RIVERS' LABORS

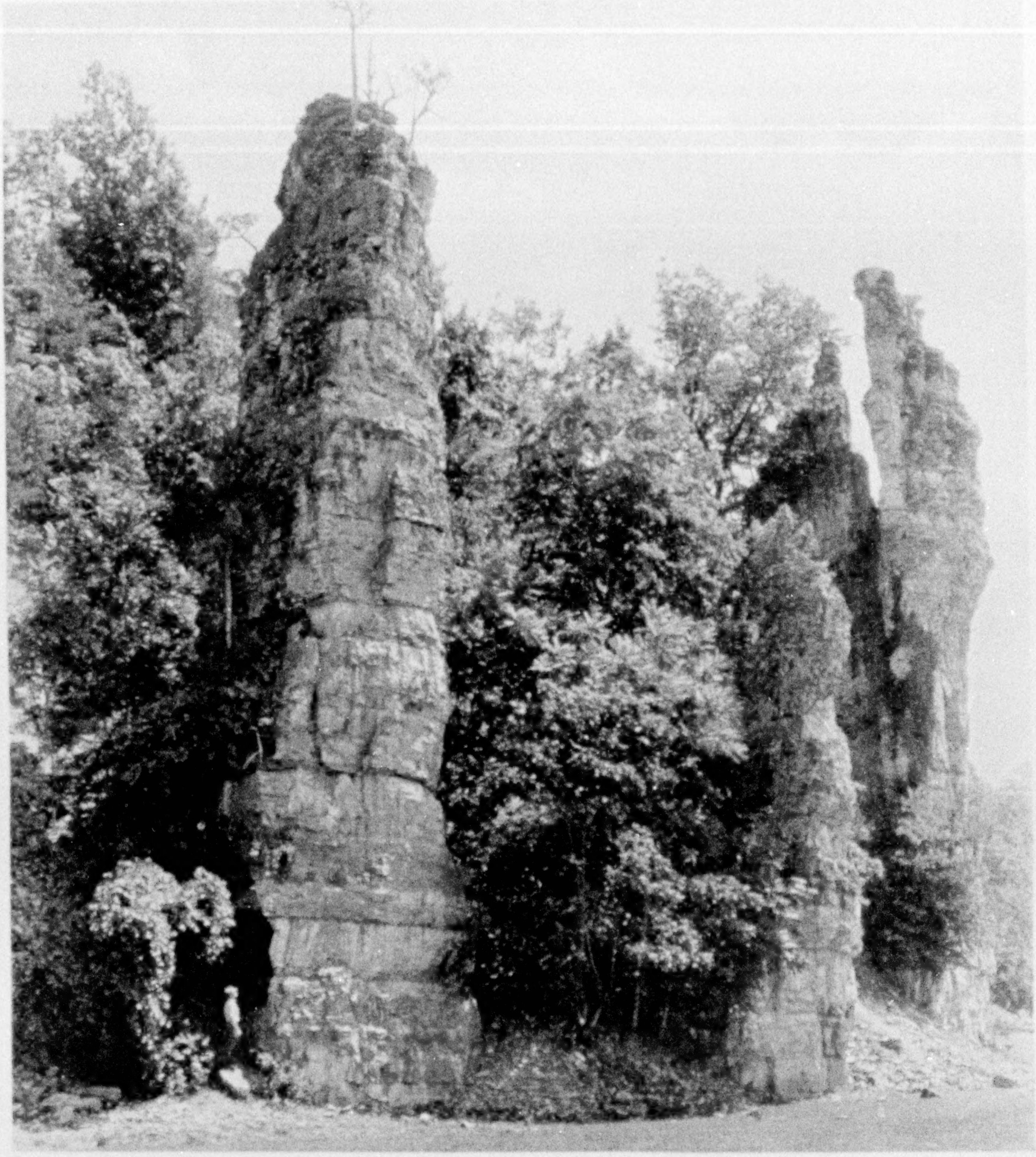
Would you measure the spoils of their warfare in the course of their existence? Then visualize the largest solid trainload of coal you ever saw, and reflect that the Mississippi delivers an equal quantity of silt, sand, and solubles into the Gulf of Mexico every eight minutes of a normal day. Or consider that the great valleys of Pennsylvania and Virginia are giant trenches dug in high plateaus whose surface once was even higher than the present-day general level of the crests of the mountains that border them.

Or, better yet, recall the tens of thousands of yards of sedimentary rock that underlie the surface of the ground, and remember that every foot of that rock is composed of material torn from the surface of the primeval granite, transported as sand and silt, reincarnated as sandstone and shale, only to be reëroded, retransported, and reincarnated repeatedly before it assumed its present form.

The forces of erosion are the munitions of the rivers' warfare; the sedimentary rocks and soil the fruits of their carnage; and landscapes the trophies of their age-long conflicts.

Like mankind, rivers wage two kinds of warfare—their united struggles against Nature and their individual and collective conflicts against one another.

In the former category is their unending battle against the mountains, the high plateaus, and the hills. If they actually, instead of figuratively, abhorred inequalities in land elevation, and if they were sentient beings, they could not battle more



Photograph by E. S. Shipp

THE NATURAL CHIMNEYS OF AUGUSTA COUNTY, VIRGINIA

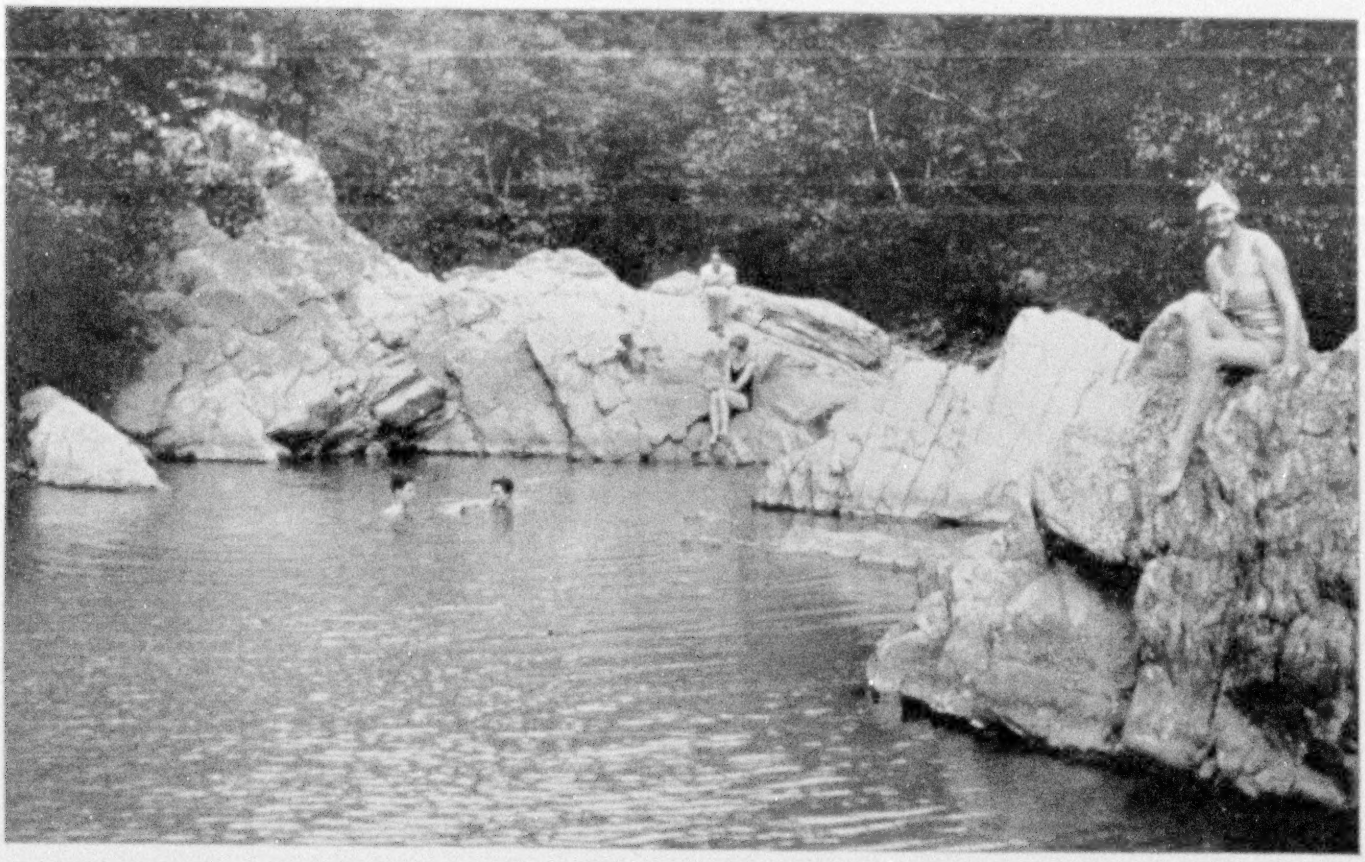
These cyclopean towers, standing on the bluffs that border North River, one of the streams that the Shenandoah captured for the Potomac, show how the river has cut down its plain in a comparatively short time, geologically speaking. They happened to be harder than the material that once surrounded them, and consequently resisted the effort of the river to carry them piecemeal seaward.

unrelentingly or more successfully against elevated areas than they do.

EVERY HILL AND MOUNTAIN SHALL BE MADE LOW

The internal forces of the earth are forever producing inequalities in its surface. Fossil river valleys that trench the continental shelves out to the very edge of the abysmal ocean, and fossil marine shells that star the soil and stone of the highest mountains, tell of eras when portions of the beds of the sea were high and dry and when the summits of our mountains lay beneath the ocean's waves.

Against these changes in level the rivers have ever set a unanimous face. They could not stop the changes, but they have



Photograph by E. S. Shipp

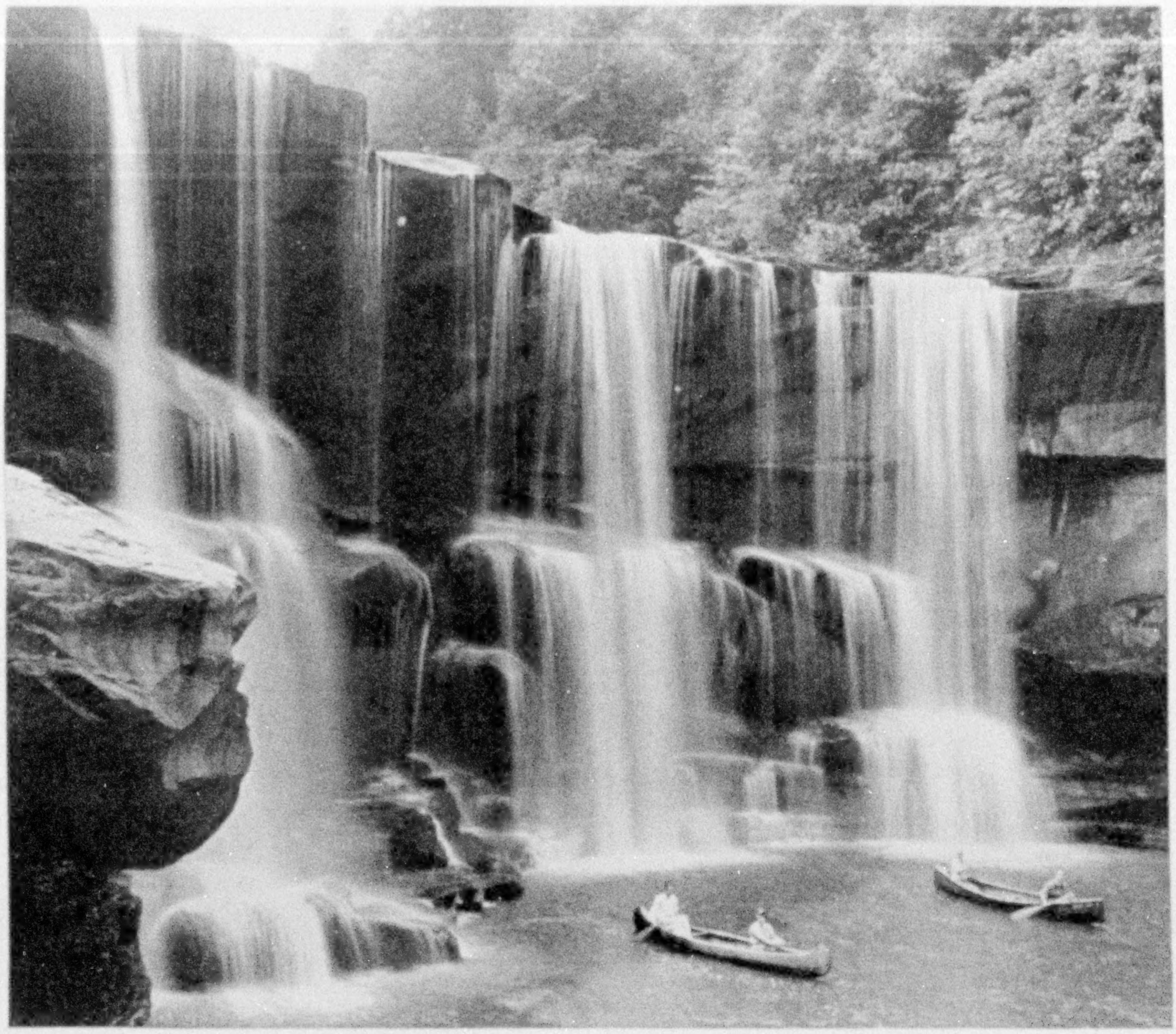
LORELEI OF JENNINGS CREEK, IN NATURAL BRIDGE NATIONAL FOREST, VIRGINIA

Sometimes the busy waters of a hurrying stream find an inviting place to bide-a-wee. Here they create "swimmin' holes."

Photograph by J. D. Sayre

LAKE GROSVENOR, A BEAUTY SPOT OF THE KATMAI REGION, ALASKA

This lake, named by the discoverer in honor of the President of the National Geographic Society, is connected with Lake Coville by a swift stream. Their waters are drained into Lake Naknek through the Savonoski River. Though these lakes will, in the usual course of events, hold their own for thousands of years, ultimately the very swiftness of the rivers that drain them will eat away the barriers that impound their waters, and their floors, like that of the once majestic Lake Agassiz, will become rich plains (see text, page 122).



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CUMBERLAND FALLS, THE PRIDE OF THE BLUE GRASS STATE

These falls bear testimony to the varying degrees of success with which running water erodes various strata of rock.

labored always to obliterate them. Isaiah drew a perfect picture of their strategy in plowing down the mountains, in building up flood plains of the valleys, and in the action of rivers in their tendency to straighten their courses, when he wrote: "Every valley shall be exalted, and every mountain and hill shall be made low: and the crooked shall be made straight and the rough places plain."

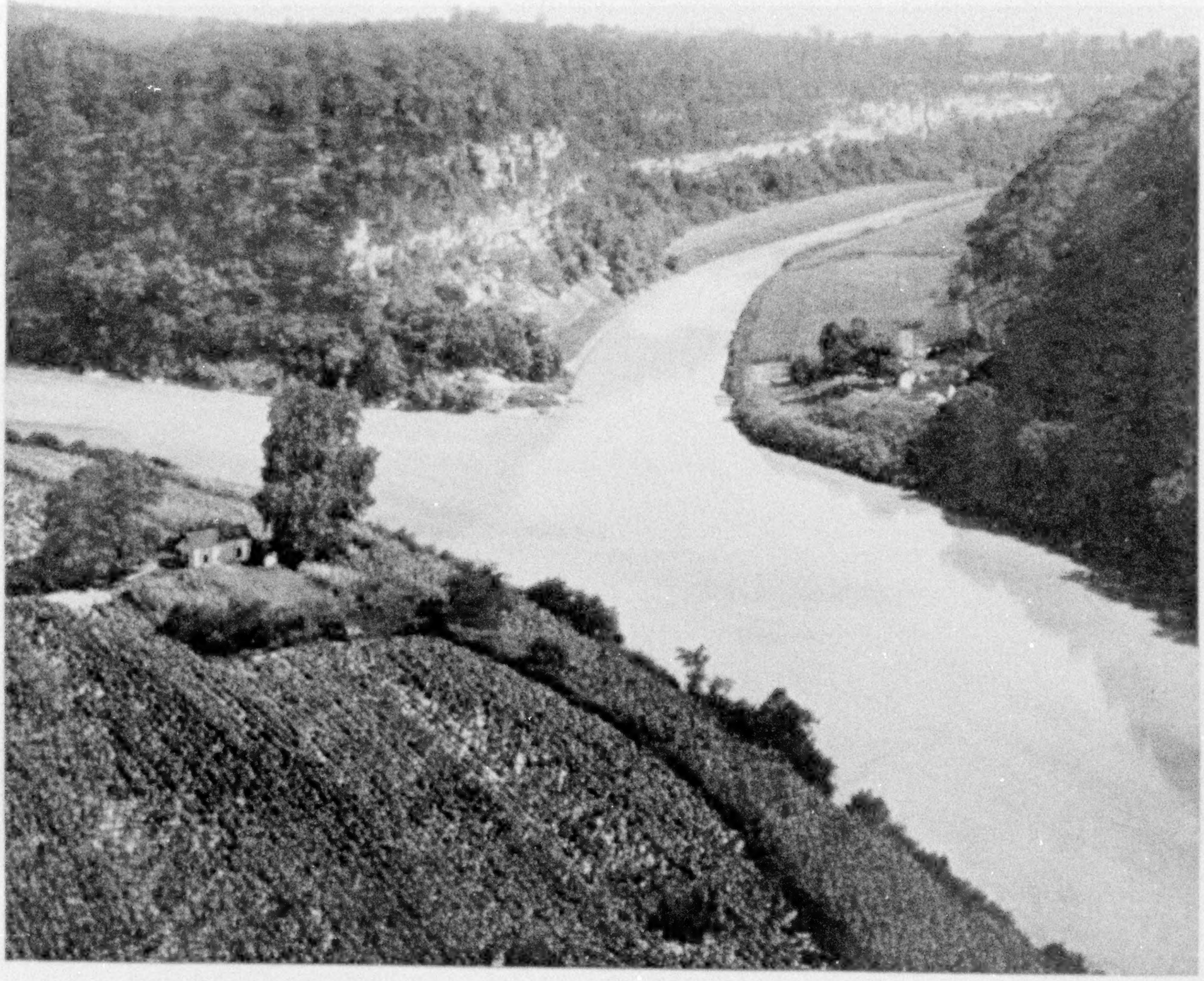
Geology aids the student to reconstruct the ancient landscapes and to visualize the geography of the long ago before the rivers we know took up their work. By it we can, if I may draw heavily a romantic background upon which facts may be reflected, bring back into pictured existence the imposing mountains that covered New England, of which the present Greylock, Mount Tom, Monadnock, and their sister sentinels of the countryside are but the vanishing remnants.

To-day's young ridges of southern Oregon, recently upheaved and only slightly gullied, ravined, and canyoned by the young rivers that drain them, afford a picture of the landscape of what we now call New England, eons before the first Pilgrim touched the famous Rock.

Likewise, the Alps, vigorous and deeply trenched, with adolescent valleys, dashing rapids, white-watered cascades, and silvery waterfalls, typify the New England scenery of a later epoch, when the rivers were tasting the fruits of victory over the mountains.

A TASK FOR A TITAN

Could some Titan fill the great valleys of the Delaware, the Susquehanna, and



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THE CONFLUENCE OF THE KENTUCKY AND DIX RIVERS AT HIGHBRIDGE, KENTUCKY

the Shenandoah to the levels that characterized them in the days before the rivers attacked them, what an empire of busy cities, fertile farms, and inspiring landscapes would be buried beneath from one thousand to two thousand feet of stratified limestone.

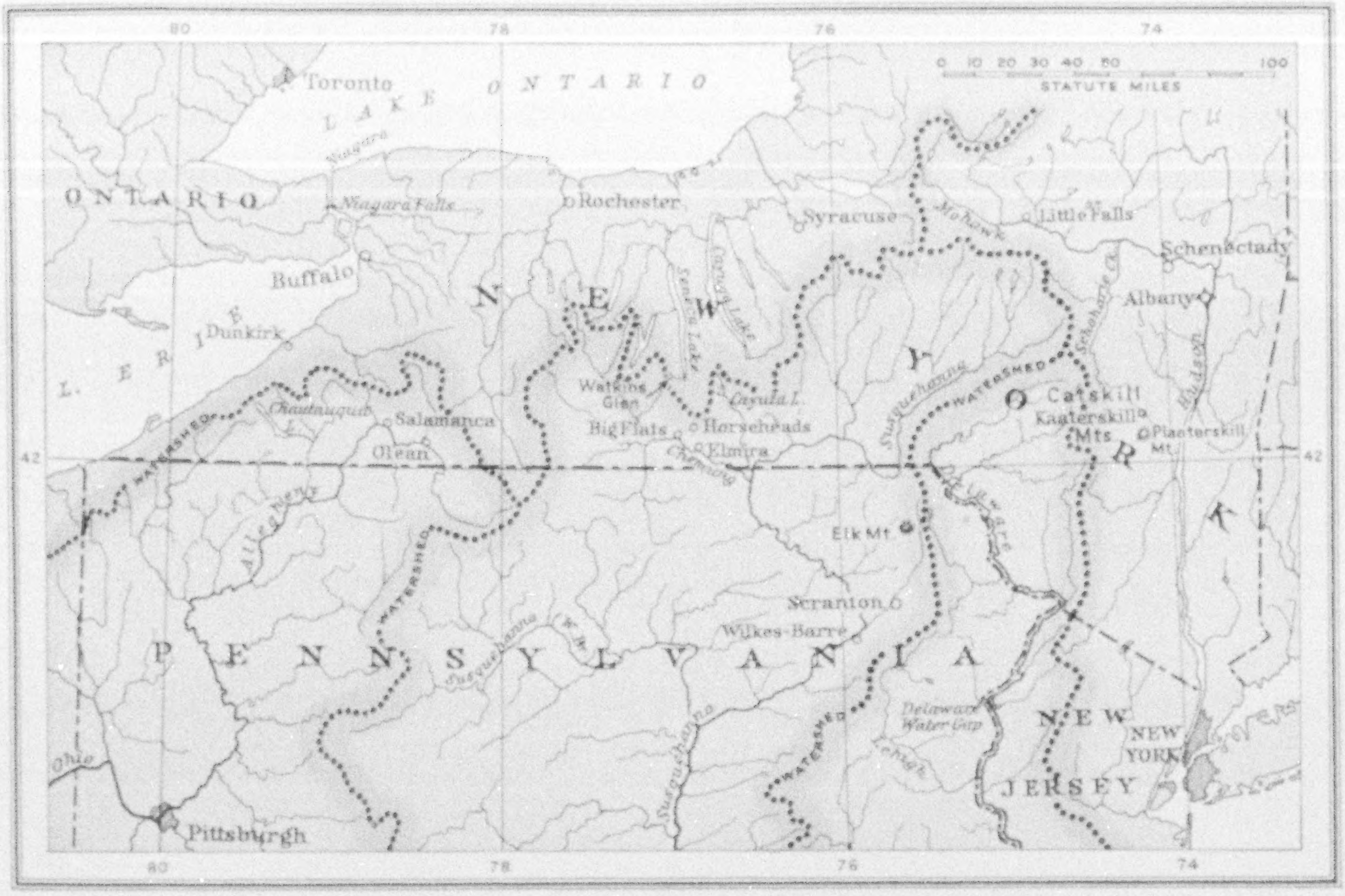
Those fine, level mountain crests pierced by the Delaware at the Watergap represent the level of the land over which the Delaware first flowed to the sea.

For more than a thousand miles the Ohio has cut a trench, that averages perhaps a mile wide and several hundred feet deep, through strata of limestone, shale, sandstone, and conglomerate. The strata on the two sides of the great Ohio trench match so perfectly that even the casual traveler down the Ohio can see that they were once joined and were sawed asunder by the unremitting industry of the great river.

In the Mississippi Valley from Cairo to St. Paul the Father of Waters has cut out a trench from two to three times as broad as that of the Ohio, and one must travel far to discover a greater or more inspiring panorama of a master stream's conquests than the trip from St. Paul to Cairo affords.

A WARLORD RIVER'S CASTLES AND TEMPLES

Likewise, the Grand Canyon of the Colorado, where the War Lord of the Arizona plateau has builded a city of temples and castles, of towers and minarets, which make the mightiest structures that man has reared seem only small-scale and colorless models; the canyons of the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78
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STATUTE MILES
Toronto
LAKE ONTARIO
Niagara
ONTARIO
Niagara Falls
Rochester
Syracuse
Mohawk
Little Falls
Schenectady
Albany
Buffalo
Dunkirk
LAKE ERIE
NEW YORK
Seneca Lake
Canandaigua Lake
Schoharie Cr.
Hudson
Watkins Glen
Cayuga L.
Susquehanna
WATERSHED
Catskill
Kaaterskill
Mts
Planterskill Mt.
Chautauqua
Salamanca
Olean
Big Flats
Horseheads
Elmira
Chemung
42
Allegheny
Delaware
Elk Mt.
Scranton
Wilkes-Barre
PENNSYLVANIA
Susquehanna W. B.
Delaware Water Gap
Lehigh
NEW JERSEY
NEW YORK
Ohio
Pittsburgh

Drawn by C. E. Riddiford

THE FRONT-LINE TRENCHES OF THE RIVERS OF NEW YORK

The dotted lines show the areas drained by the master rivers of the Empire State, most of which have driven spearheads into the terrain of their rivals. It is particularly interesting to note how the east fork of the Susquehanna has driven its way northward to the very ramparts of the Mohawk at Little Falls.

Photograph by A. C. Spencer

THE BIRTH OF AN ALASKAN GLACIAL STREAM

Many a furrow that later formed the bed of a stream has been plowed by glacial ice. Likewise it has driven many a river into the lap of a rival watercourse (see text, page 117).

Yellowstone and the Columbia; and the Castle Gate and the Royal Gorge of the Arkansas—all these proclaim the mighty nature of the major battles the rivers have waged in the exaltation of the valleys and the laying low of the mountains and the hills.

Just as mankind's outstanding struggle is against the forces of Nature, and his minor ones contests between nations, communities, groups, and individuals, so rivers and creeks, brooks and rills, stage their infighting with one another for territorial conquest and drainage control.

THE BOLDEST OF BUCCANEERS

The tales of pirates bold and buccaneers brave have ever stirred the imagination of the youth that is in us all; but the adventures of the Morgans and the Captain Kidds of human history are stories of weak and transitory exploits as compared with those of the predatory rivers of geologic time.

The people of Virginia, North Carolina, and Tennessee are to-day arranging to dedicate to the Federal Government, for the use of the people of the United States, as national parks, areas in the Blue Ridge and the Great Smoky Mountains which constitute the Spanish Main of the pirate rivers of North America.

Perhaps the Shenandoah ranks as the boldest buccaneer of American river history. No more daring a pirate ever trod a quarter-deck or scuttled a ship than was this liquid torrent in an earlier era of its life, although nowadays it is so delightful that it has stirred even the stolid Indian to poetic fancy and led him to name it the "Daughter of the Stars."

If you have ever motored through piedmont Virginia from Point of Rocks to Charlottesville, or up the Shenandoah Valley from Harpers Ferry to Staunton, you are probably familiar with that outstanding series of wind gaps in the Blue Ridge from Bluemont to Waynesboro.

Long ages ago Beaverdam and Goose creeks, and the Rappahannock, Rapidan, and Rivanna rivers did not rise, as now, on the seaward slopes of the Blue Ridge, but, like the Potomac and the James, had their sources in the outrider ridges of the Alleghenies. The Shenandoah Valley, in those days, was a limestone plateau level with the crest of the Blue Ridge.

Like the present-day rivers of Norway that flow across a high plateau and then dash wildly down the mountain sides to the sea, making possible the wonderful Norwegian hydroelectric development, the Virginia streams flowed across this plateau and down the mountain sides of the Blue Ridge, and danced merrily on to the lower Potomac and Chesapeake Bay.

STREAMS THAT WERE FORCED TO WALK THE PLANK

But the soft and soluble limestone of the Valley area yielded faster than the harder and more resistant sandstone and heat-treated trap rock of the Blue Ridge.

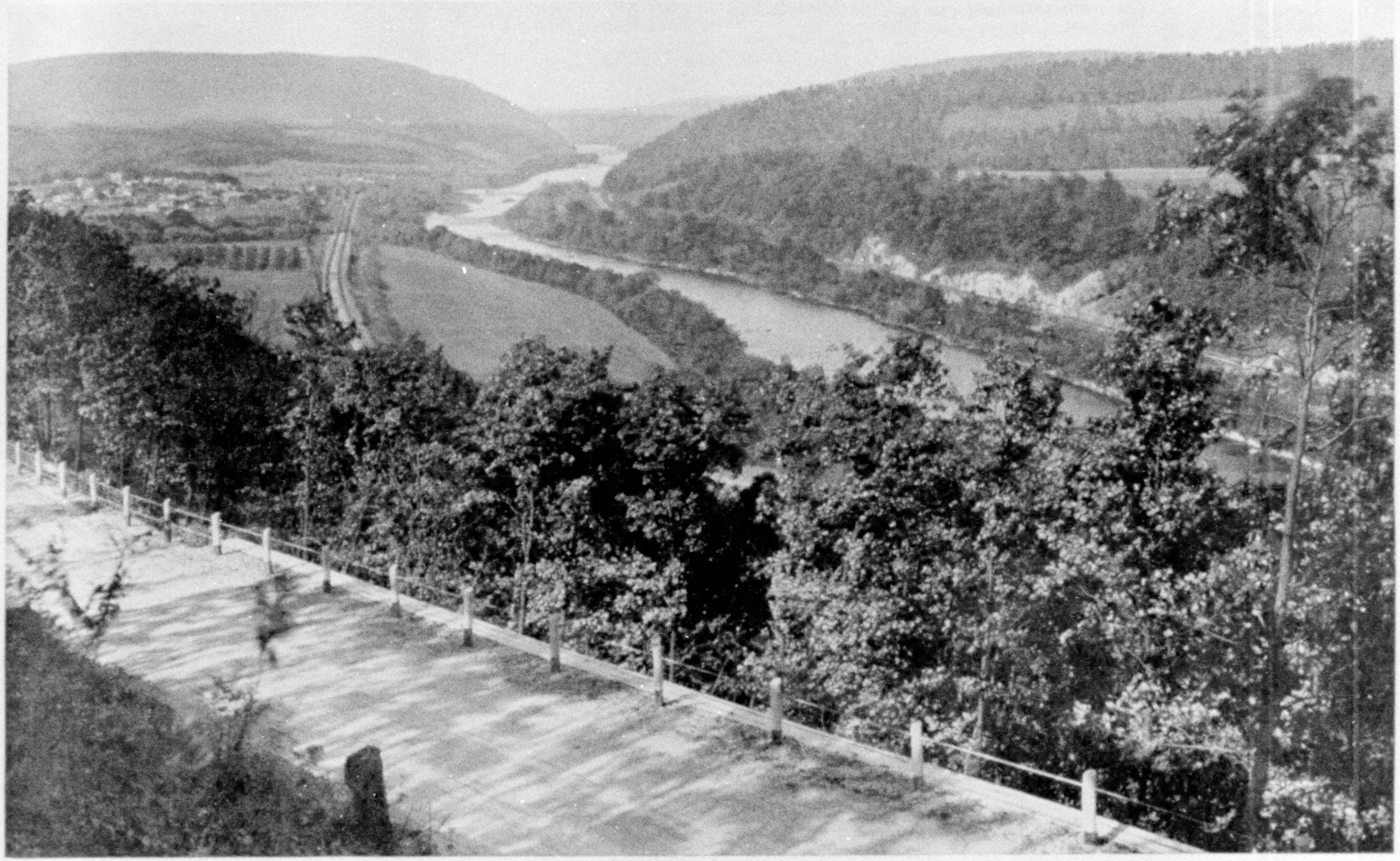
So presently the grade was against them—a grade they were no longer able to make. As though realizing its opportunity to capture their fluvial wealth, the Shenandoah pushed its way up the deepening valley, and eventually the headwaters of all of these streams were the "pieces of eight" with which the Shenandoah loaded its galleons and bought the favor of its sovereign, the Potomac.

And Rockfish Gap, Browns Gap, Swift Run Gap, Thorntons Gap, Clarkes Gap, Manassas Gap, Ashbys Gap, and Snickers Gap to-day are eloquent, if silent, witnesses of the exploits of the pirate Shenandoah in robbing them of their liquid wealth.

The Potomac and the James, stronger rivers than their ancient corulers of the Shenandoah region, were able to hold fast to their gaps by wearing them down as fast as the valley level behind the Blue Ridge was reduced; hence to-day we have at Harpers Ferry and Balcony Falls gorges of unsurpassed beauty in the Blue Ridge.

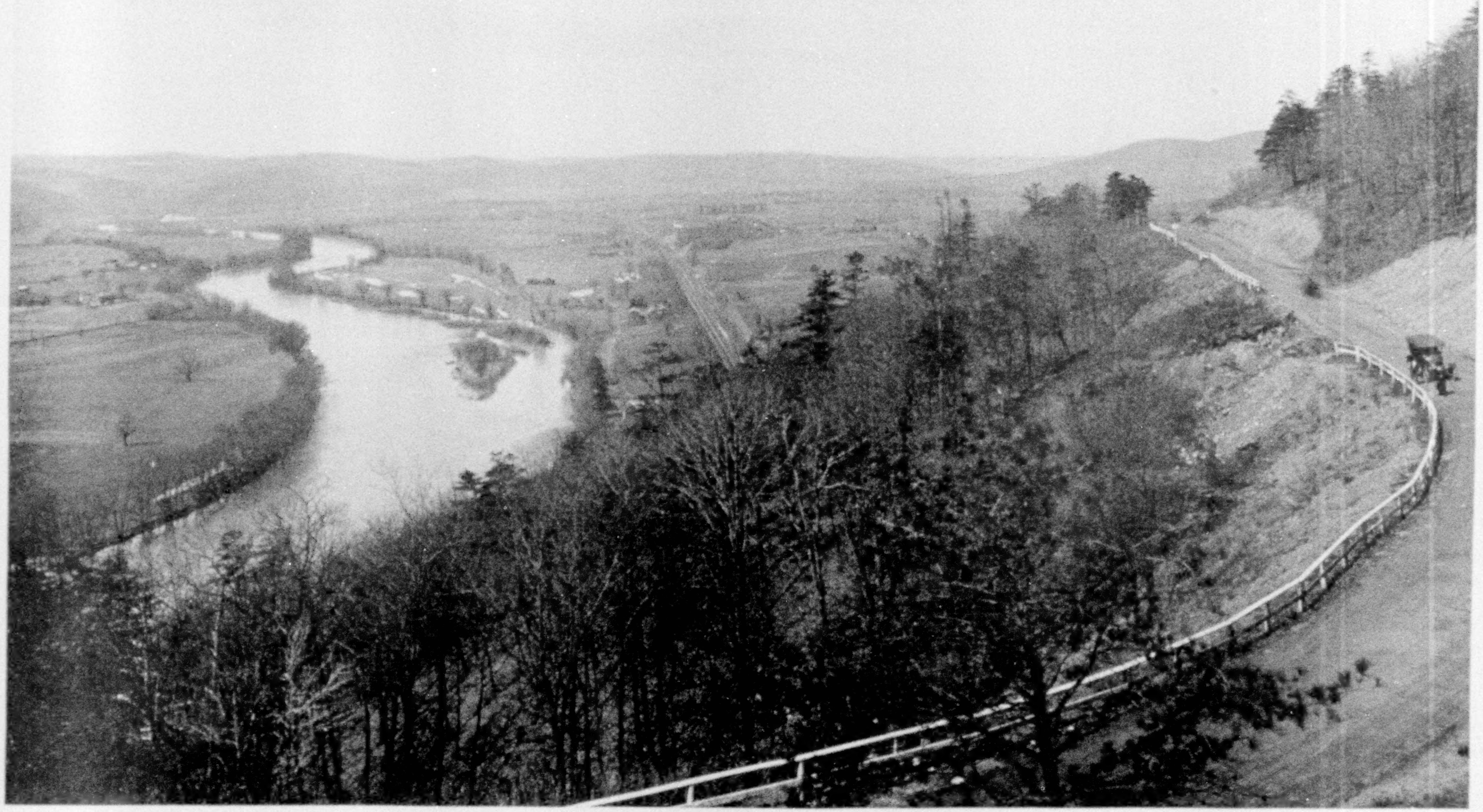
Even the James, however, has no assurance that it will always be permitted to tenant its gap at Balcony Falls. Inch by inch the headwaters of the Shenandoah are pushing back the divide, and there are unmistakable indications that in ages yet in the far distant future the stately river with the kingly name may itself be beheaded by the Shenandoah, sharing the fate that in bygone ages befell its sister rivers—the Rappahannock, the Rapidan, and the Rivanna.

In the high valley between the Blue Ridge and the Great Smoky Mountains, in western North Carolina, one may inspect



OVERLOOKING THE POTOMAC RIVER AND THE HILLS OF MARYLAND FROM THE VICINITY OF GREAT CACAPON, WEST VIRGINIA

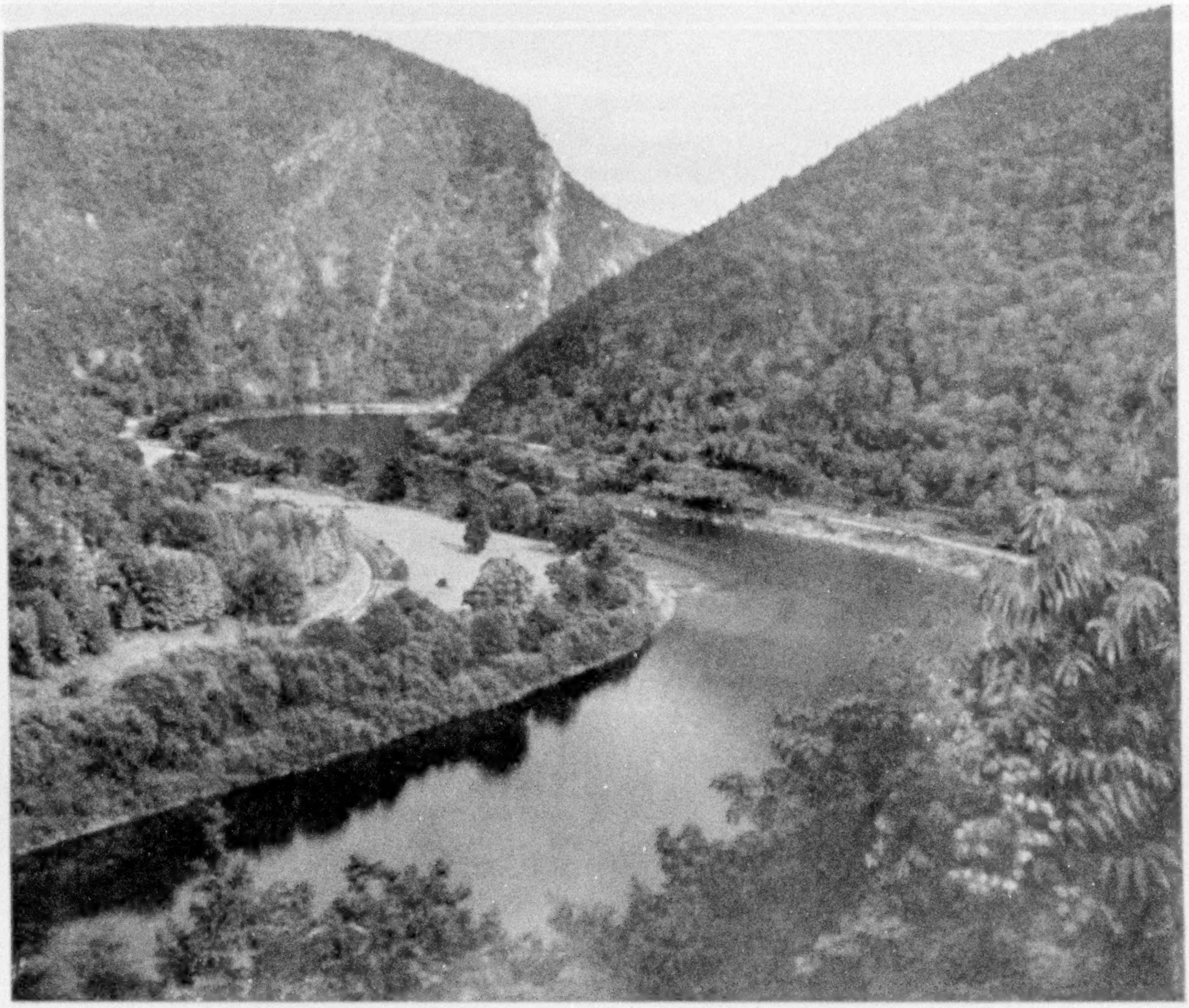
The power of rivers is eloquently portrayed by water gaps. The Delaware's thousand-foot deep channel through the Kittatinny Mountain, the Potomac's gorges at Harpers Ferry and Great Cacapon, the Royal Gorge of the Arkansas in Colorado, and hundreds of others show that soft, yielding water may be sterner than the heights of mountains.



Photograph by Fred T. Loomis

THE CHEMUNG RIVER, WITH WAVERLY HILL TO THE RIGHT, NEAR ELMIRA, NEW YORK

This stream was able to hold its ancient course for the most part when the Ice Age crept down over New York, but west of Elmira, near Big Flats, it was pushed out of its channels and forced through a narrow valley as far as Elmira, where it regained its old bed.



Photograph by W. H. Rau

WHERE THE DELAWARE RIVER CONQUERED THE MOUNTAINS

One is prone to think of rivers as following their valleys; but, as a matter of fact, in the vast majority of cases the rivers were there before the valleys appeared. What ages must have rolled by since the Delaware River began its task of cutting its present majestic way through the mountains that lie between Port Jervis and the sea!

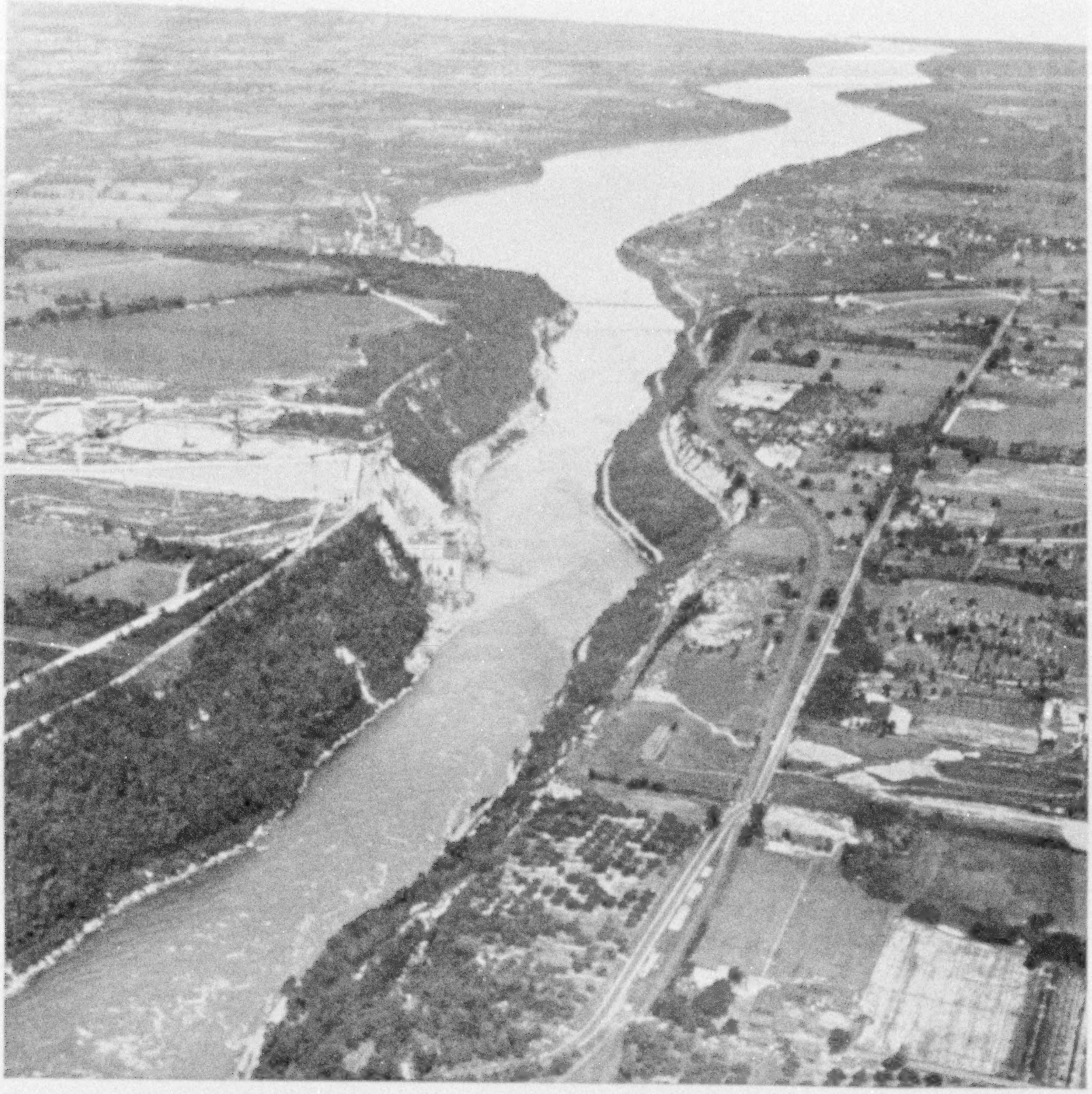
another of the great river battlefields of the world. The stories its landscape tells of Titanic struggles over watersheds, of battles over divides, and of fights without quarter over stream beds, are legion.

In the geological long ago a magnificent stream occupied this great, canoe-shaped structural valley that began in southwest Virginia and ended in northwest Georgia. One branch of this river rose in southwest Virginia and flowed in a southwesterly direction past Asheville, where it was joined by the other branch, which had its headwaters in the extreme southwest corner of North Carolina, and flowed by Murphy, Bryson City, and Waynesville to its confluence with its sister fork a little below Asheville.

Their mingled waters ran along the upper valleys of the present French Broad River and Mud Creek; thence into South Carolina and out to the Atlantic Ocean.

A HORDE OF ENVIOUS WATER WOLVES

It was truly a beautiful region which this river drained. Underlaid with heat-hardened rock, it was rugged—even more so than the Lake Toxaway-Asheville-Land-of-the-Sky country, its present successor.



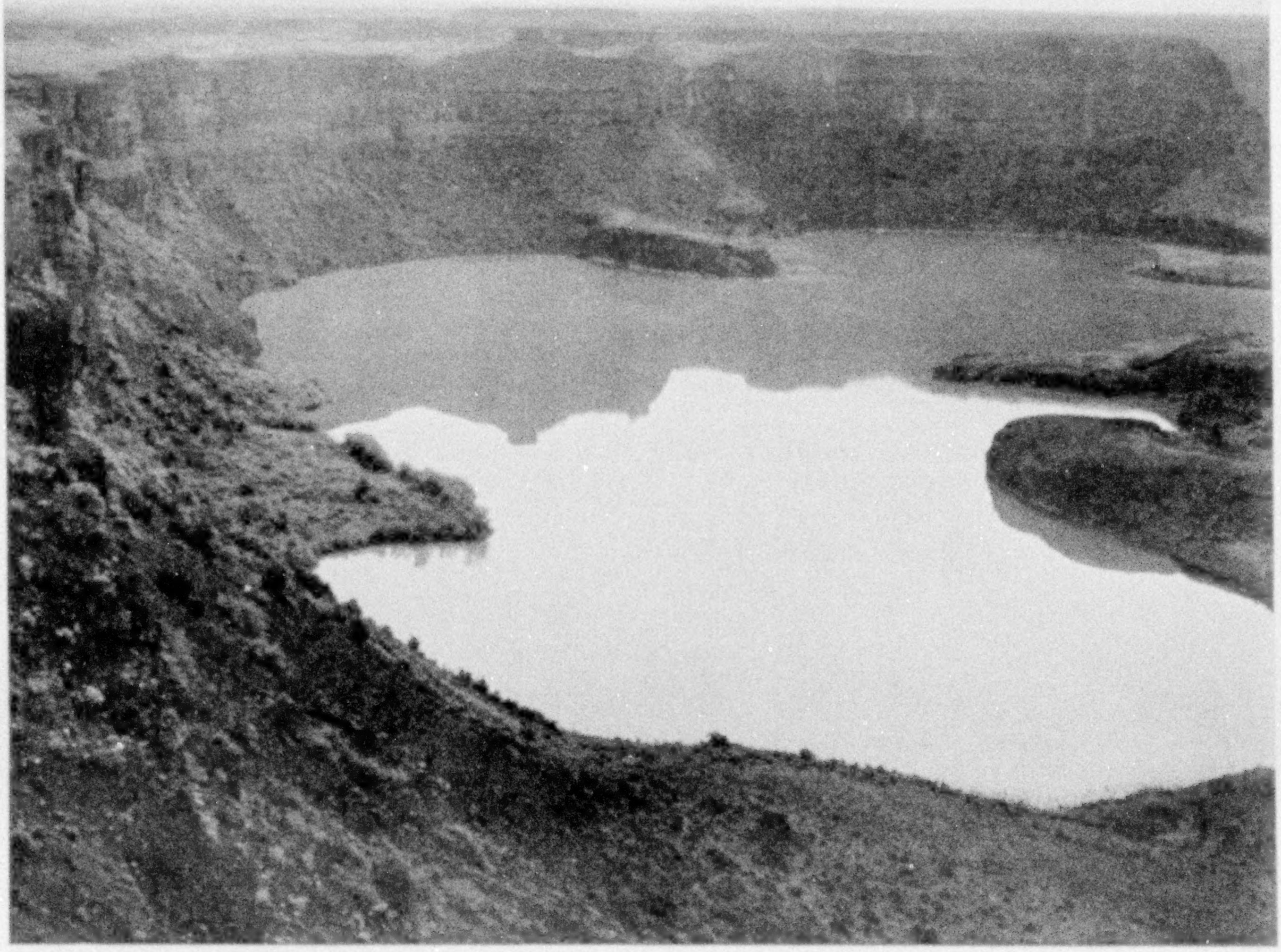
Photograph by Ronne and Washburn

WHERE NIAGARA RIVER LEAVES ITS GORGE AND ENTERS THE PLAIN EN ROUTE TO LAKE ONTARIO

The vastness of the span of geological time is strikingly shown at Niagara. The record read in the rocks shows that there was no Niagara River and no Niagara Falls until after the Ice Age. The majestic chasm which the river has cut attests the length of time it has been at work. And yet Niagara River is but a new-born stream compared with some of the hoary-aged rivals for the waters it carries.

It was too fair a land to escape the attention of many great master rivers. The Ohio, through its distant tributary, the New, set to work to conquer it. Likewise, the Catawba, through its tributary, the Linville, also sought to bring it under subjection. The Savannah gave letters of marque to the Tallulah, bidding that stream capture its rhythmic waters. To the west was the Tennessee River, sharp as a Toledo blade and hungry for new worlds to conquer.

Yes, the Great Smoky Mountains lay between the Tennessee and the majestic intramontane principality whose waters it would capture. But did not that river have many staunch tributaries to whom even the embattled heights of the Great Smokies were not impossible barriers, and were they not ready to launch attacks in



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A MUTE WITNESS TO A ONE-TIME SUPER NIAGARA

The cliffs in the background are known as the Grand Coulée of the Columbia River. Over them the Columbia once flowed to plunge more than 400 feet; but in most of its course this river has defied alike the processes of earth upheaval and lava intrusion, maintaining its channel through some startling convulsions of Nature.

a half dozen sectors of the besieged river's dominions?

There they were—the Hiwassee, the Little Tennessee, the Pigeon, the French Broad, the Nolichucky, and the Watauga. Did ever a sovereign river have a hardier fleet of outlaw craft than this to reduce a fortress and capture a silver stream?

The stage for the capture is craftily set. New River digs its way through the mountains of southwest Virginia, crosses the North Carolina line, and presently overpowers the headwaters of the northeast fork of the ancient stream, leading them in triumph down through the Kanawha into the Ohio.

Linville River is not idle in its sector. It crashes the Blue Ridge ramparts at Linville Falls with a deadly blow and carries off the waters in the basin headed by Linville Gap, dragging them down to the Catawba.

The Tallulah in its turn meets with success in its siege of the Georgia sector. It breaks through the gorge at Pulaski, where it divides its forces inside the mountains, sending one column of its white cavalry dashing westward beyond Tallulah Mountain, and the other, the Chattooga, northward, and runs up its black flag above a section of the southwest fork for its share of the loot.

Photograph by Barnett

ENTRANCE TO DONALDSON CAVE, MITCHELL, INDIANA

The maps of the world carry many "Lost Rivers" and numerous "Sinking Creeks." Limestone is noted for its fissures, and whenever water can get into ledges of this rock it not only brings the processes of erosion to bear upon it, but employs the leverage of expansion in freezing to drive the ledges asunder.

The six tributaries of the Tennessee are also engaged. The southernmost, the Hiwassee, succeeds in reducing the ramparts of the Smokies at Appalachia.

THE TENNESSEE'S SHARE IN THE ALLIED ADVANCE

Likewise, the Little Tennessee is sapping and hammering away at the Great Smokies. Four thousand feet of mountain stand defiant in its path, but even such breastworks must fall before the relentless character of its attacks, and finally the grim cutlass reaps its reward.

Nor is the doughty Pigeon inactive in this dark campaign. At Waterville it pounds its way through the Great Smoky barrier and on past Truelove Mountain, into the drainage basin in the neighborhood of Waynesville.

The French Broad River brings up its heaviest Long Toms, attacking the great mountain barrier at the Paint Rock divide. It, too, won a notable victory, capturing many hundreds of square miles of drainage area and a large section of both forks of the ancient river.

The Nolichucky, likewise, sledges away at the mountain ramparts and finally breaks through, as did the Watauga.

When all these pirate rivers had finished their work, partitioned Poland in the palmiest days of the dismemberment of nations, was never half so torn to pieces as was the master river of the ancient North Carolina Valley.

THE VALUE OF THE PRIZE

Wander through the Great Smokies and note the size of the Hiwassee, the Little Tennessee, the Pigeon, the French Broad, the Nolichucky, and the Watauga as they pass the ramparts atop which runs the North Carolina-Tennessee boundary, and see that in comparison the sack of Panama by Henry Morgan was but the yield of a pickpocket.

Glance at the New in southwest Virginia, at the Linville as it breaks through the Blue Ridge, and at the Tallulah as it flows down to swell the Savannah, and then reflect that all the waters of all these streams once flowed in a single channel through the Blue Ridge and on to the Atlantic.

Mud Creek—poor, bucolic, sluggish, turbid little trickle that you are—you occupy for a few miles the valley of a once princely river, which gathered the waters of the great Asheville-Land-of-the-Sky region and dispatched them on to the sea. Piracy has left only you to tell of the glory of the lordly stream it despoiled, and even you must run backward!

Some of the lawless streams may yet live to pay the penalty for their plundering. Hominy Creek, which once formed part of the channel of the southwest fork of the captured river, has been eating its way into the present-day divide between it and the Pigeon River. Its head is now only half a mile away from that of the lazy Pigeon and many feet below the latter's bed. Who knows but some day the now reformed Pigeon is destined to get a dose of its own ancient medicine.

One who studies the Land-of-the-Sky region's past and compares it with that of the Shenandoah Valley will be impressed with the contrasts that unfold before him.

In fact, it would not be far from the truth to say that the two regions have swapped aspects, the modern Land-of-the-Sky typifying the drainage of the ancient Shenandoah country, and the modern Valley of the Shenandoah resembling that of the ancient Land-of-the-Sky.

The wind gaps of the Virginia Blue Ridge are memorials to streams that once flowed through them, even as the Watauga, the Nolichucky, the French Broad, the Pigeon, the Little Tennessee, and the Hiwassee now cut through the Great Smokies. In Virginia the master stream was the victor. In North Carolina it was the vanquished.

THE ANCIENT ANTHRACITE RIVER'S FATE

The parceling out by rival pirate rivers of the ancient North Carolina master stream of the Blue Ridge-Great Smoky basin finds something of a counterpart in the fate that befell the once mighty Anthracite River, which long ages ago drained the Wilkes-Barre-Scranton sector of Pennsylvania.

That river, which was the outlet of lakes that then existed in the present anthracite region, flowed to the northwest through the upper part of the State.

In the heyday of its prosperity the Anthracite had neighbor streams that were seeking new worlds to conquer, one of these being the Susquehanna. Step by step the latter hewed down the divide and captured first one tributary of the Anthracite and then another. Bringing them under its own flag, it thereby gradually gained strength for its major attack and correspondingly reduced the resistance of its prospective victim.

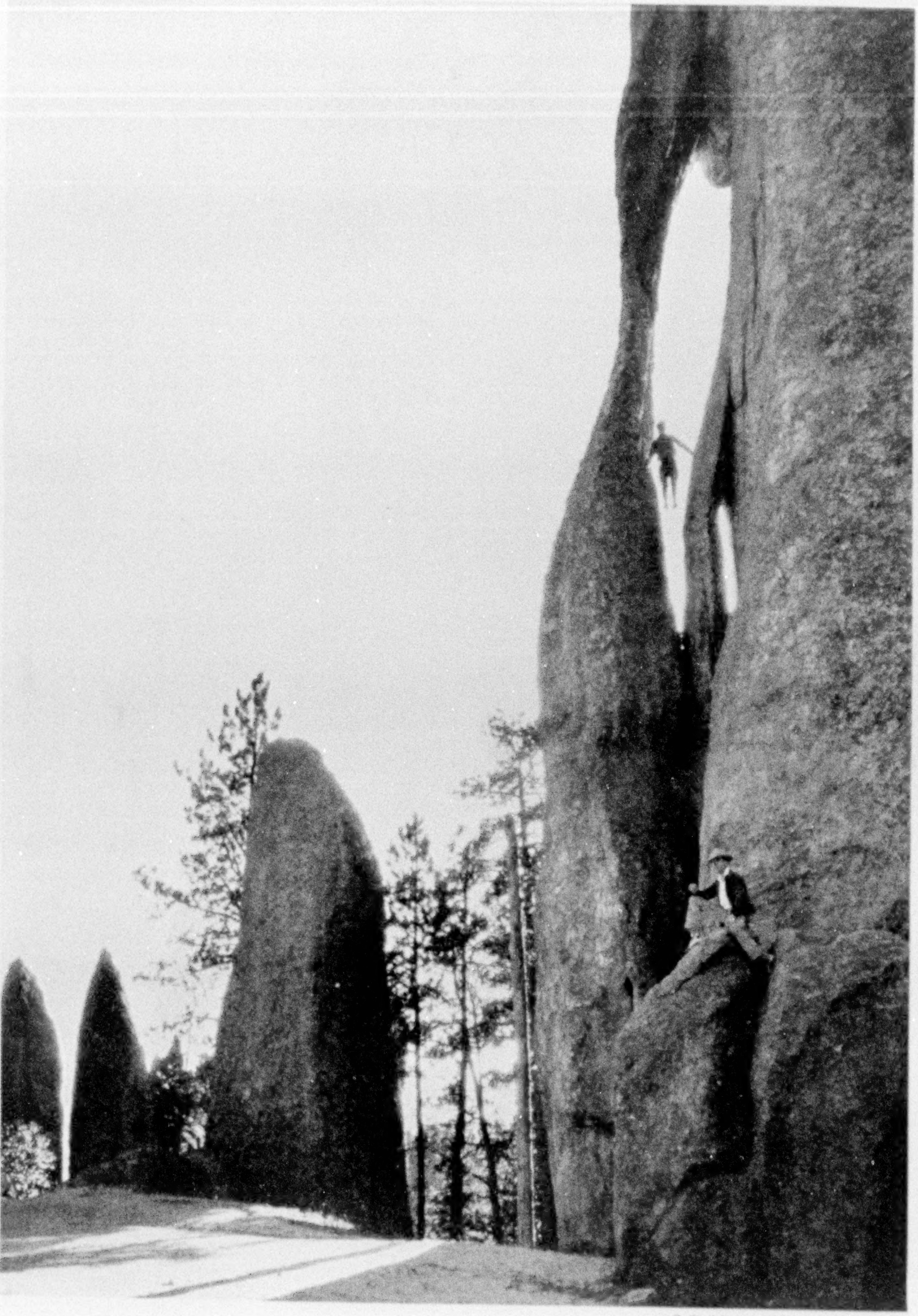
THE SCHUYLKILL BATTERS DOWN DEFENSES

Meanwhile the Lehigh was pounding away at the eastern bulwarks of the Anthracite basin; but it found the Carboniferous sandstones a defense it could not penetrate, and consequently gained little ground. The Delaware was also assailing one sector of the citadel, but likewise with little success because of the same hard sandstone in that area of the Anthracite's defenses. The Schuylkill aspired to a share, and did finally gain that part which the stronger Susquehanna left behind.

That river alone found the vulnerable spot in the ancient stream's breastworks. Pushing farther and farther, age by age, it finally captured the bulk of the main flow and led its waters in triumph to the sea, the master spoilsman of them all.

One might go on at length with this romantic type of stream piracy. In southeastern New York the capture of one of the forks of Schoharie Creek by the Plaaterskill and the Kaaterskill is a fine example of the buccaneering operations of small streams. In the Yellowstone Park country Pacific Creek seems to be battering down the Divide at Two Ocean Pass, and in the not-distant geological future probably this creek will capture the headwaters of Atlantic Creek and divert them from the Atlantic to the Pacific Ocean.

Likewise, Leatherbark Run, a tributary of the Greenbrier River in the vicinity of White Sulphur Springs, West Virginia,



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THE NEEDLE'S EYE, IN THE BLACK HILLS OF SOUTH DAKOTA

The moods of Nature in making some parts of a cliff hard and other parts soft have enabled erosion to present all sorts of bizarre shapes to twentieth-century eyes. Needle rocks, capped columns, natural chimneys, profile rocks, etc., are a few of these many peculiar creations.

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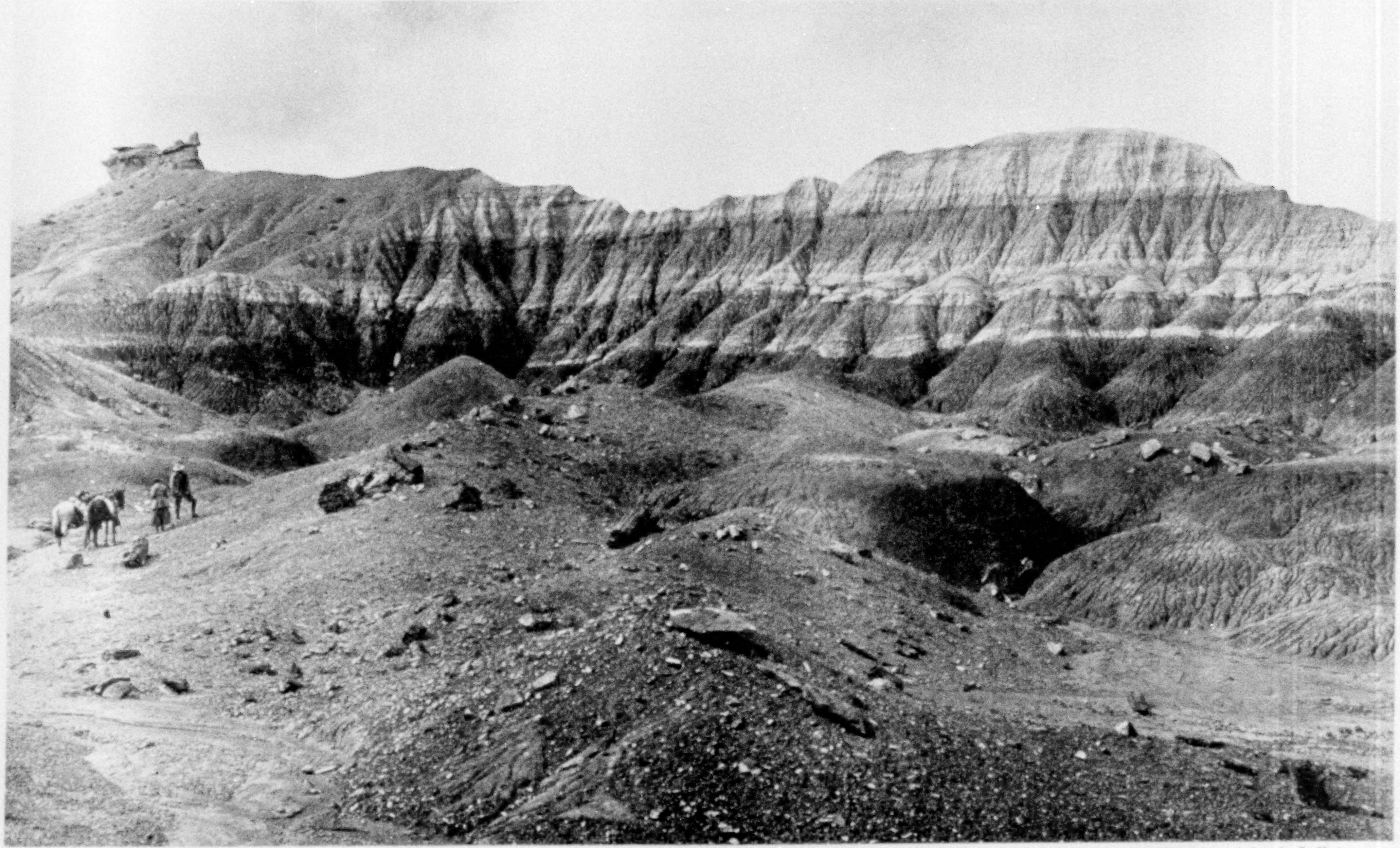
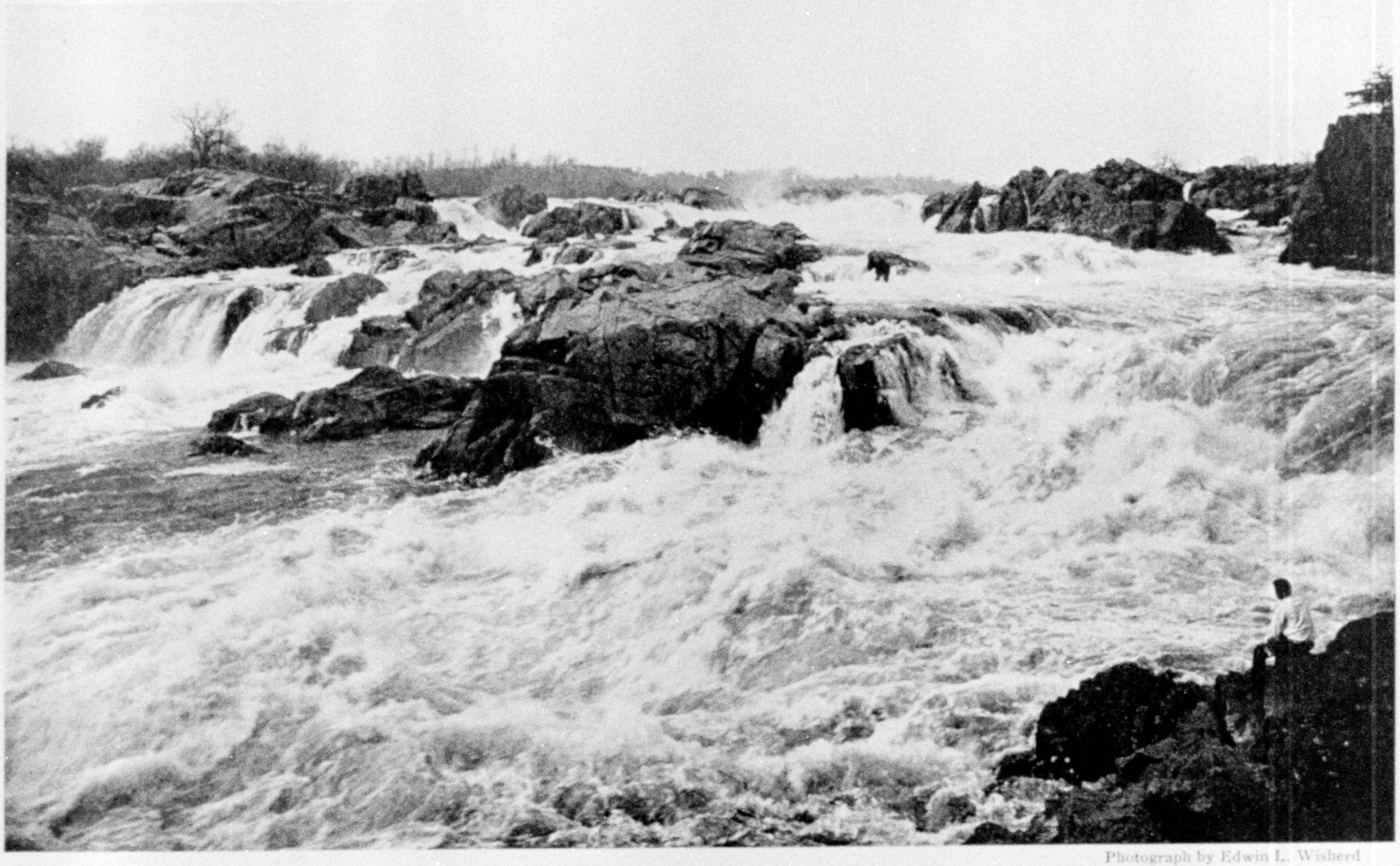
THE RESTFUL WATERS OF MINNEHAHA, MINNEAPOLIS, MINNESOTA



Photograph by A. J. Baker

EVERY STRATUM A PAGE IN THE BOOK OF NATURE!

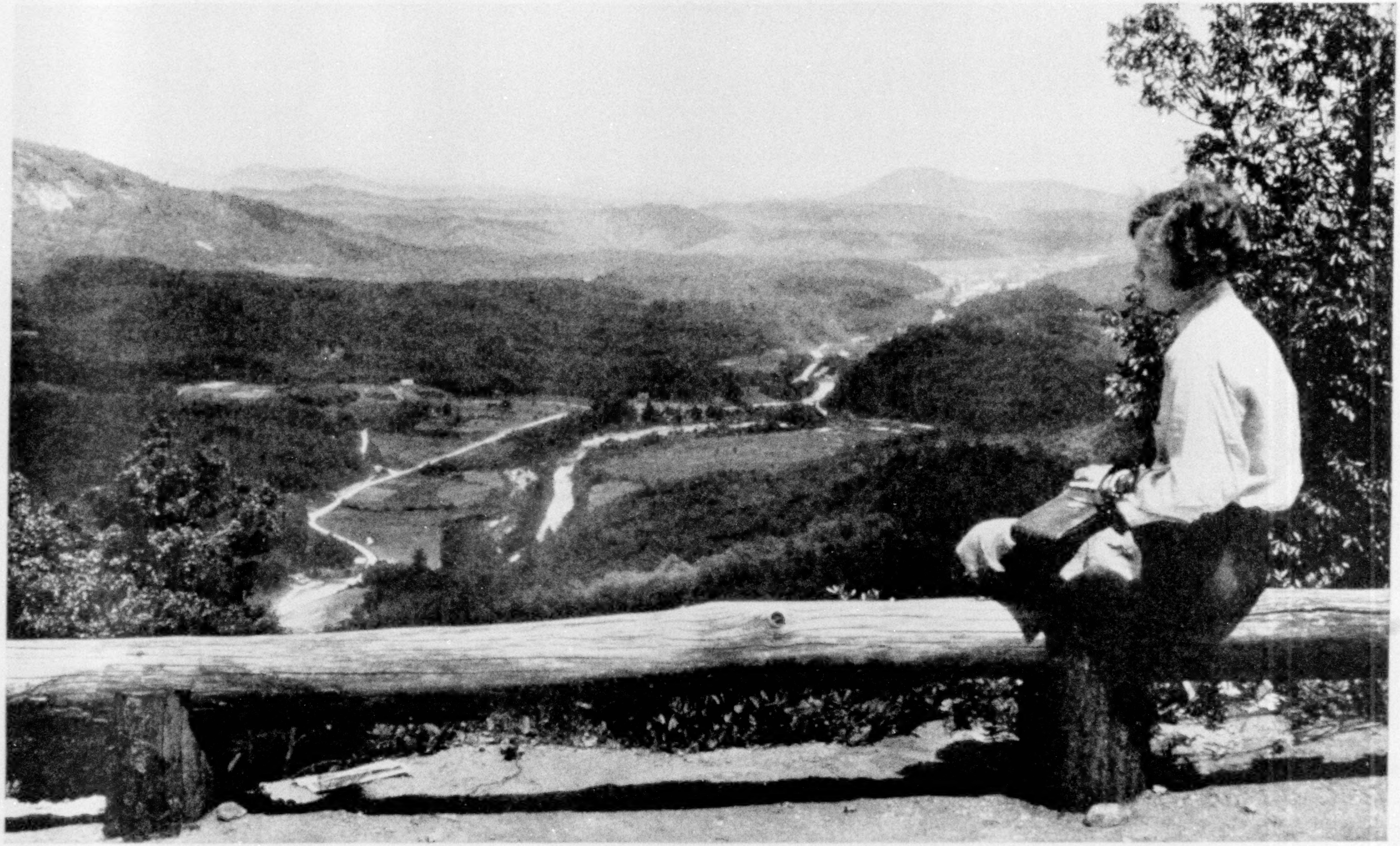
The Petrified Forest in Arizona tells to the geologist as many stories of the past as did Scheherazade to the Sultan in the *Arabian Nights*. It speaks of a vastly changed climate, of mineral matter taking the place of wood, of seas that once rolled where forests had grown, and where desert conditions now reign.



Photograph by Edwin L. Wisherd

GREAT FALLS OF THE POTOMAC

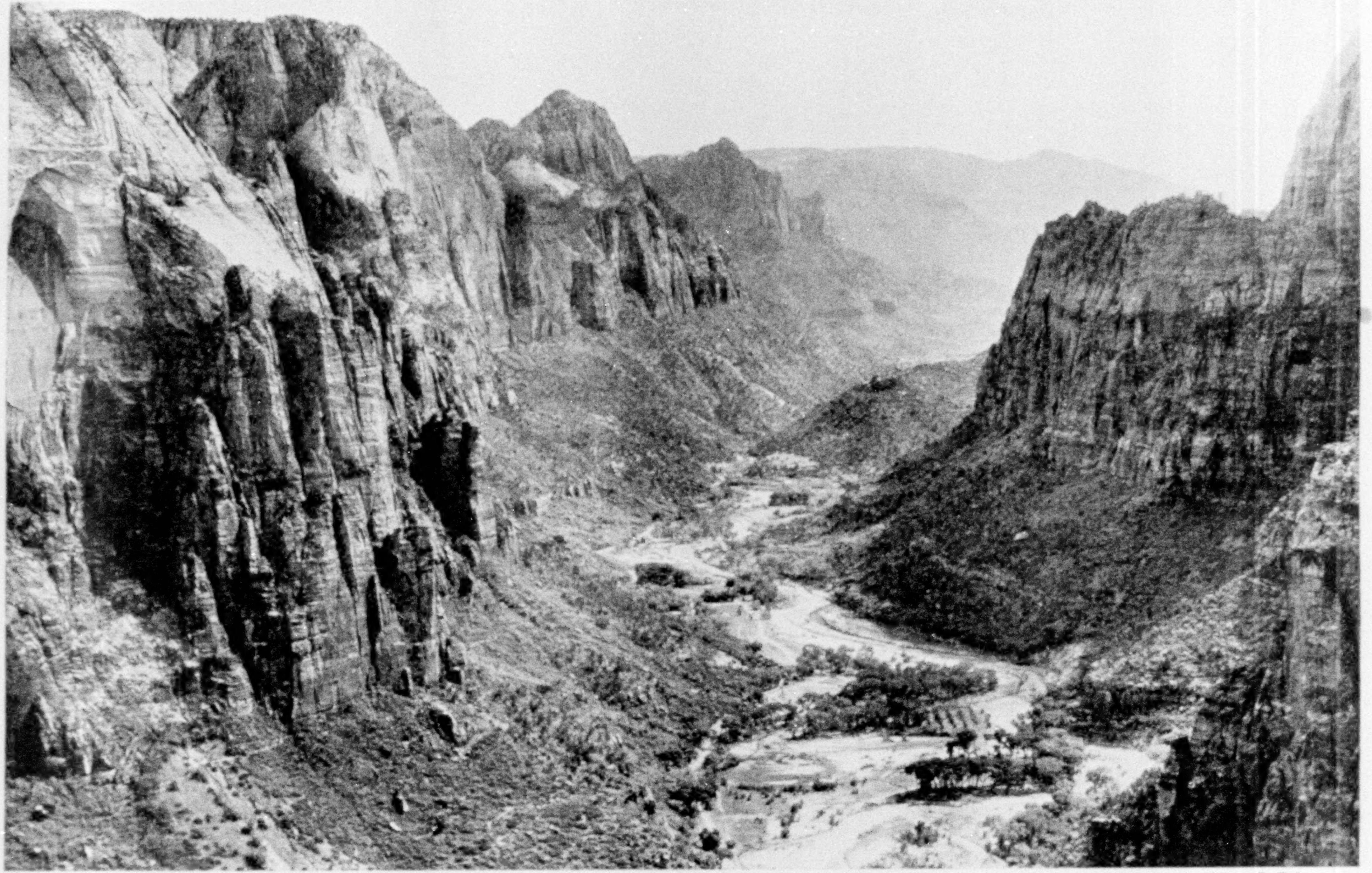
Weary at last of their long battle against the mountains and hills of western Maryland, northwestern Virginia, northeastern West Virginia, and southern Pennsylvania, the waters of the Potomac here dance like victorious soldiers at the end of a conflict, as they leap down to the peaceful plains of the tidewater section of the stream, where war's stern duties are at an end.



Photograph by Clifton Adams

THE BROAD RIVER VALLEY, FROM CHIMNEY ROCK, NORTH CAROLINA

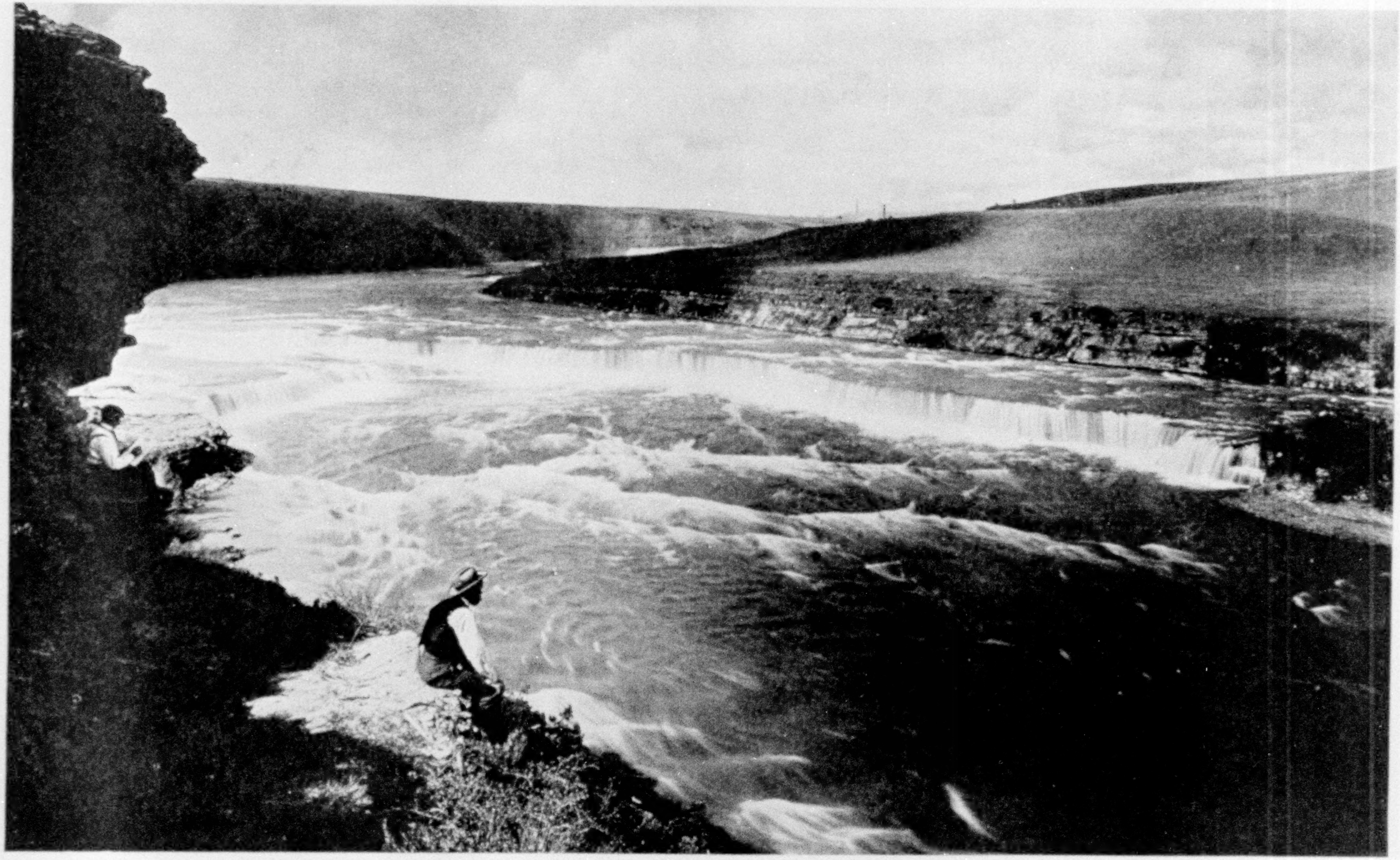
A dam is being built which soon will impound the Broad River's waters in an artificial lake 27 miles in circumference. Man will thus transform the stream's mountain-razing energy into civilization-building work (see, also, illustration, page 110).



Photograph by Oliver J. Grimes

LOOKING DOWN ZION CANYON FROM THE TOP OF ANGELS LANDING: ZION NATIONAL PARK

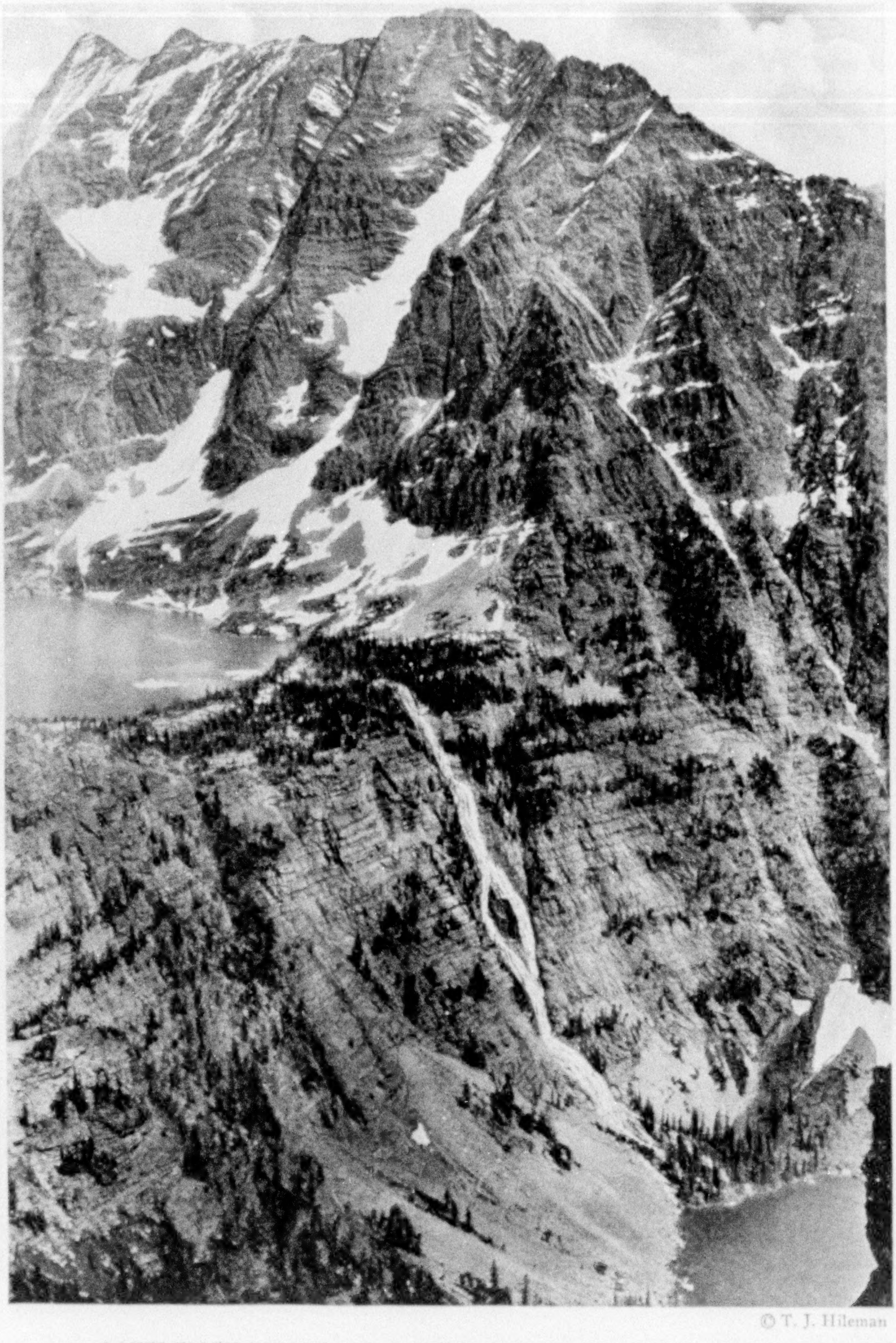
"The forces of erosion are the munitions of river warfare, the sedimentary rocks and soil the fruits of their carnage, and landscapes the trophies of their age-long conflicts" (see text, page 87).



Photograph courtesy U. S. Geological Survey

HORSESHOE FALLS OF MISSOURI RIVER, CASCADE COUNTY, MONTANA

This, one of the major rivers of America, is believed by some geologists to have flowed at one time into Hudson Bay, through the Red River of the North, but that it was driven to the southeast by the great ice advance and forced to become a tributary of the Mississippi (see page 124).



© T. J. Hileman

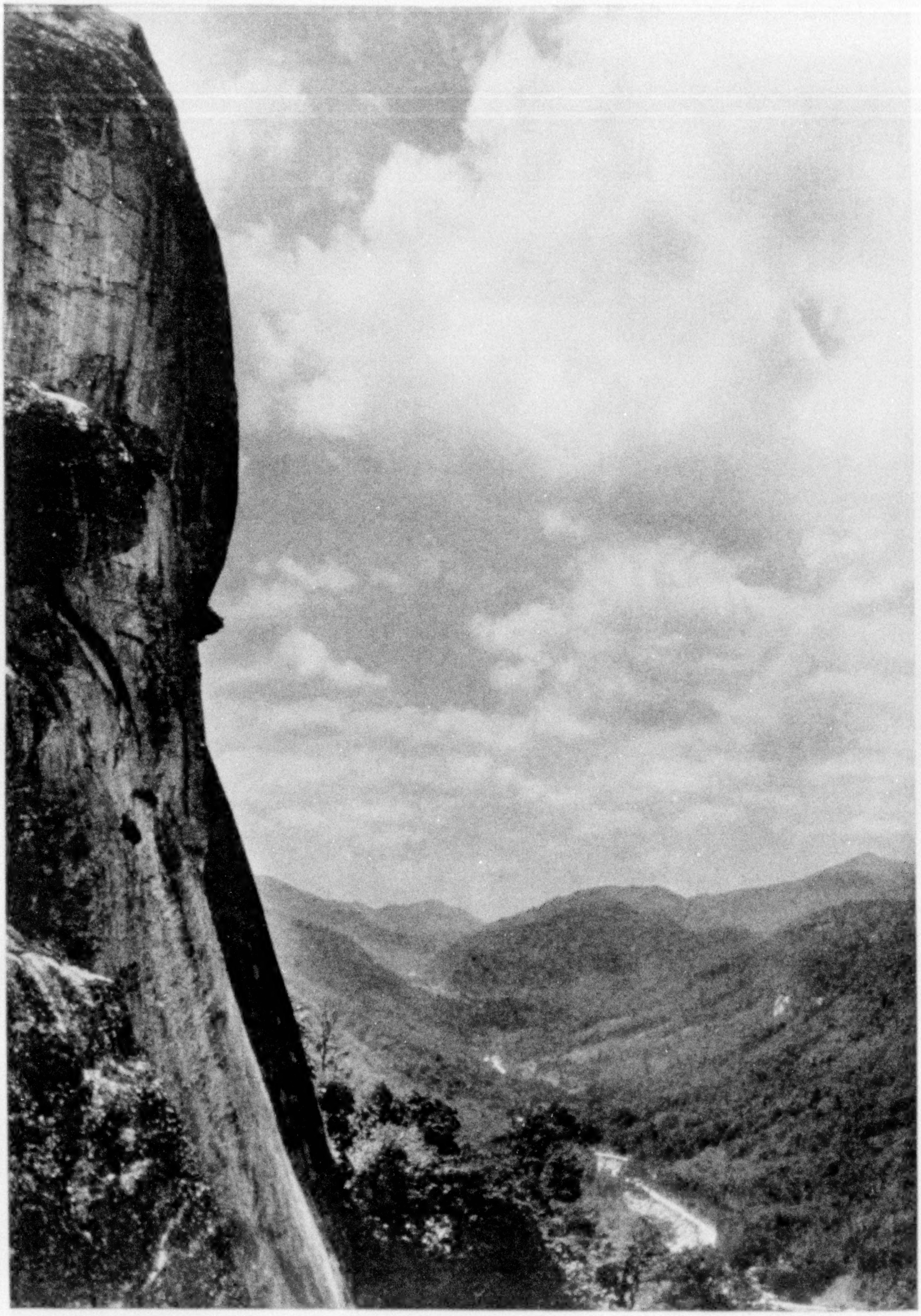
LAKES ELLEN WILSON AND SAINT MARY: GLACIER NATIONAL PARK

These two lovely bodies of water, lying in the shadow of Mount Jackson, are connected by Diamond Falls, which have a drop of 1,400 feet. On the surface of the upper lake small icebergs are generally afloat.

© H. Armstrong Roberts

WHEN PIRATE WATERS SLEEP

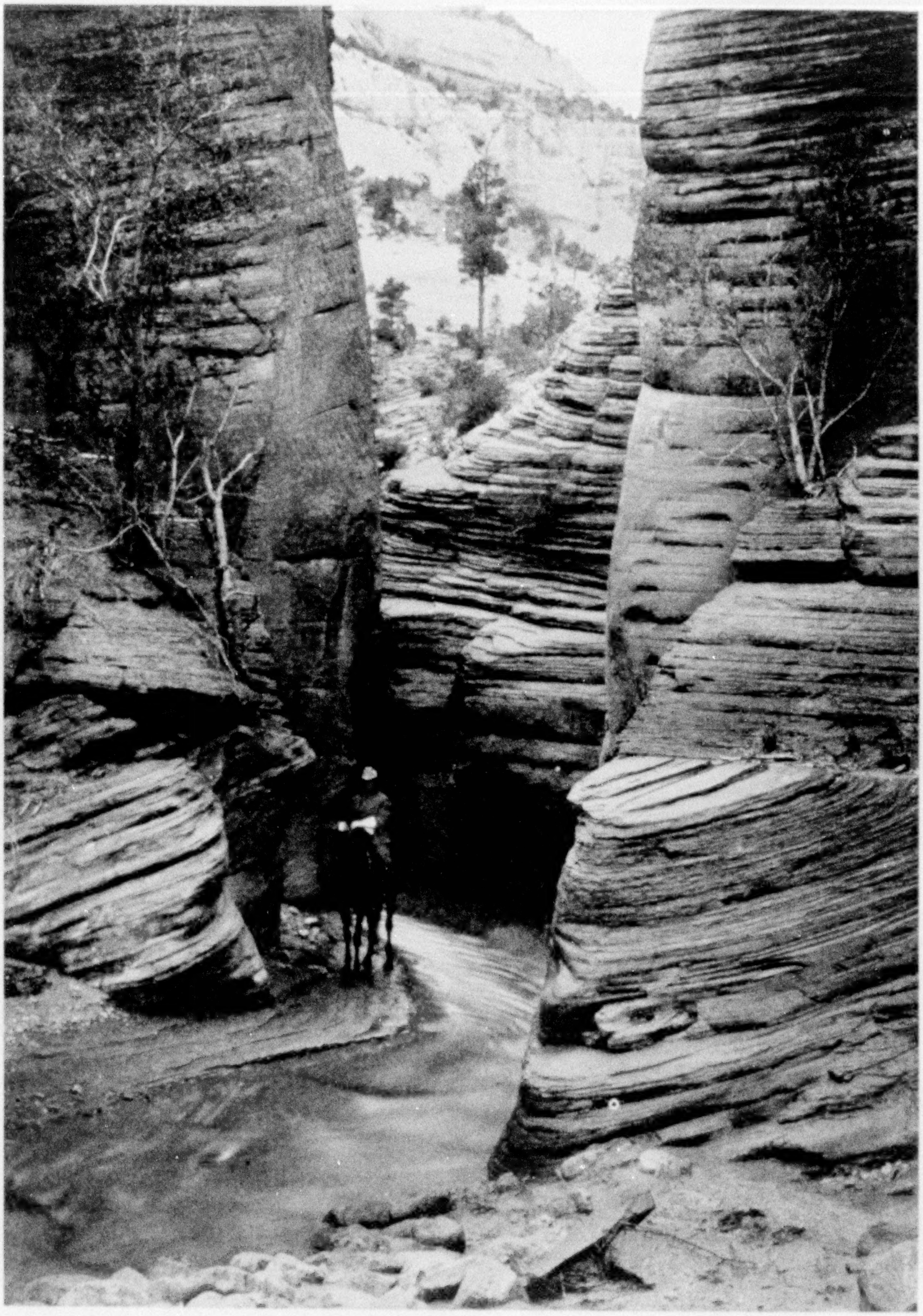
Streams have their "seven ages" as well as man, and after the hurly-burly of warfare against the rocks and the hills they settle down eventually to feeble-flowing, erosionless, liquid highways (see text, page 87).



Photograph by Clifton Adams

BROAD RIVER VALLEY FROM CHIMNEY ROCK, NORTH CAROLINA

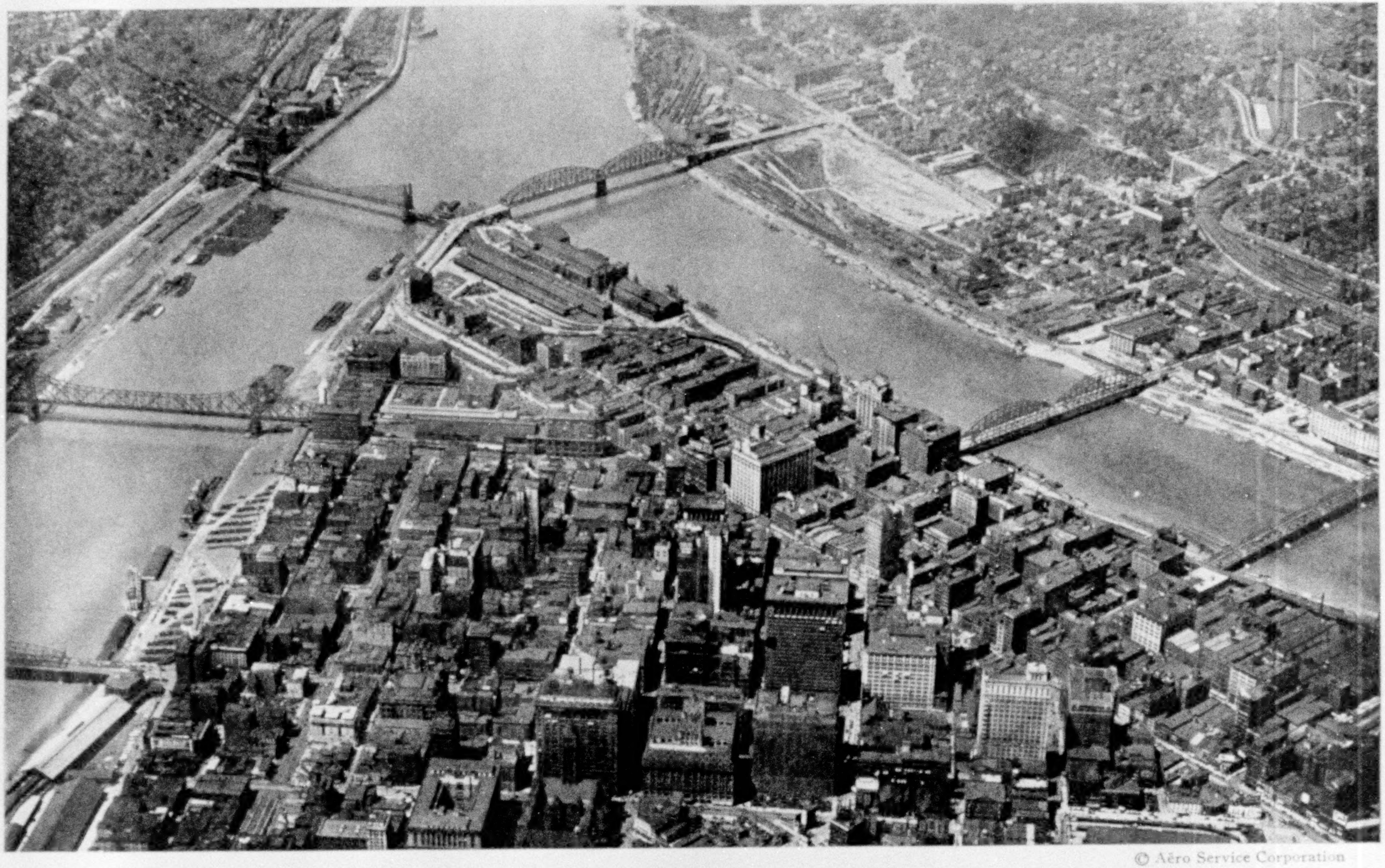
In the high valley between the Blue Ridge and the Great Smoky Mountains, in western North Carolina, one may study pirate river tactics on one of the great geological battlefields of the world (see text, pages 97-100, also, illustration, page 105).



Photograph by George R. King

LITTLE MEADOW GULCH, IN ZION NATIONAL PARK: UTAH

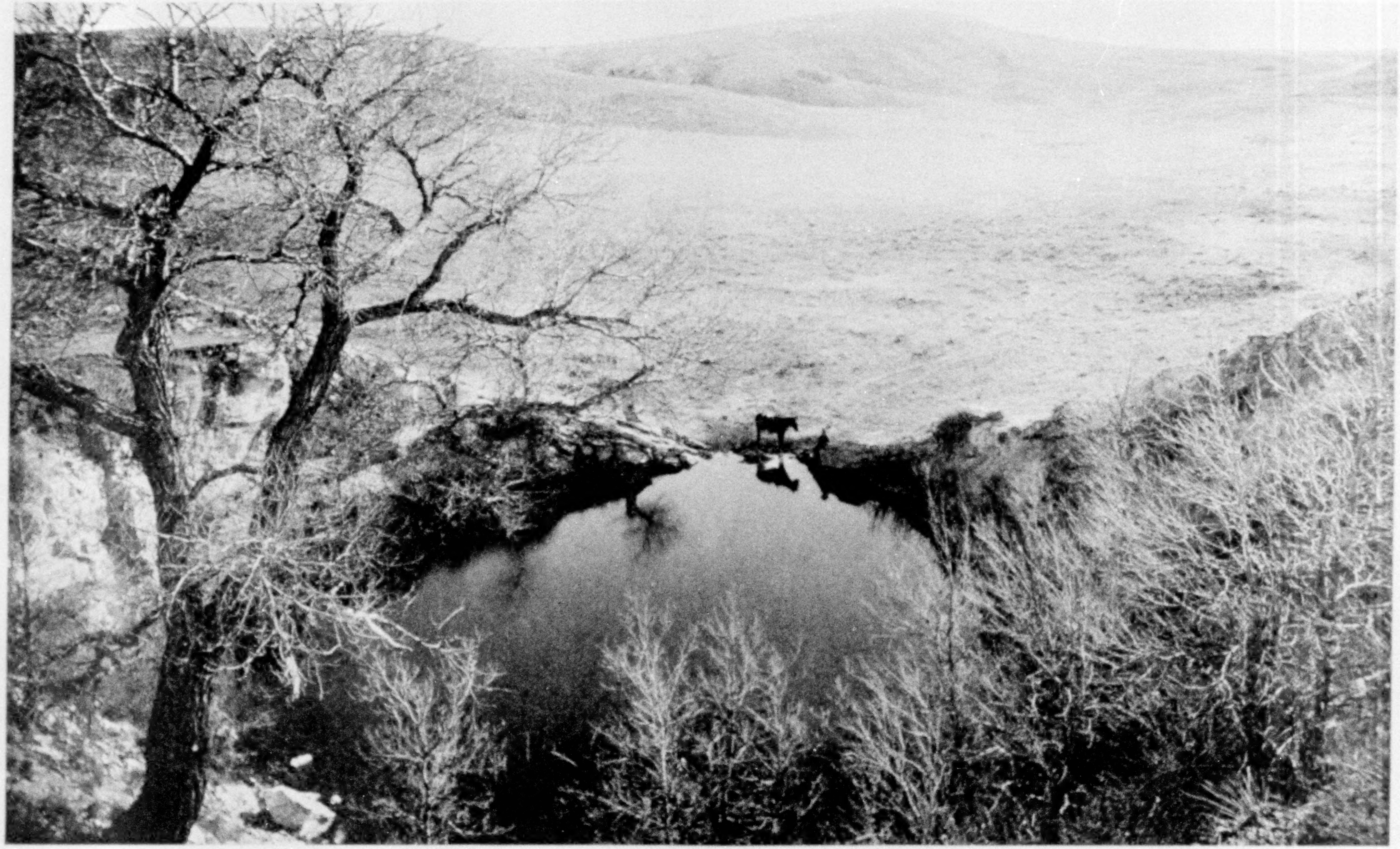
As a result of stream erosion in the high plateaus of Utah, deep, narrow gulches have been cut in sandstone 3,000 feet thick, ranging in color from deep red to white. This formation is believed to be due to wind-blown sand—fossil sand dunes.



© Aëro Service Corporation

WHERE THE MONONGAHELA AND THE ALLEGHENY JOIN FORCES AT PITTSBURGH TO MAKE THE OHIO

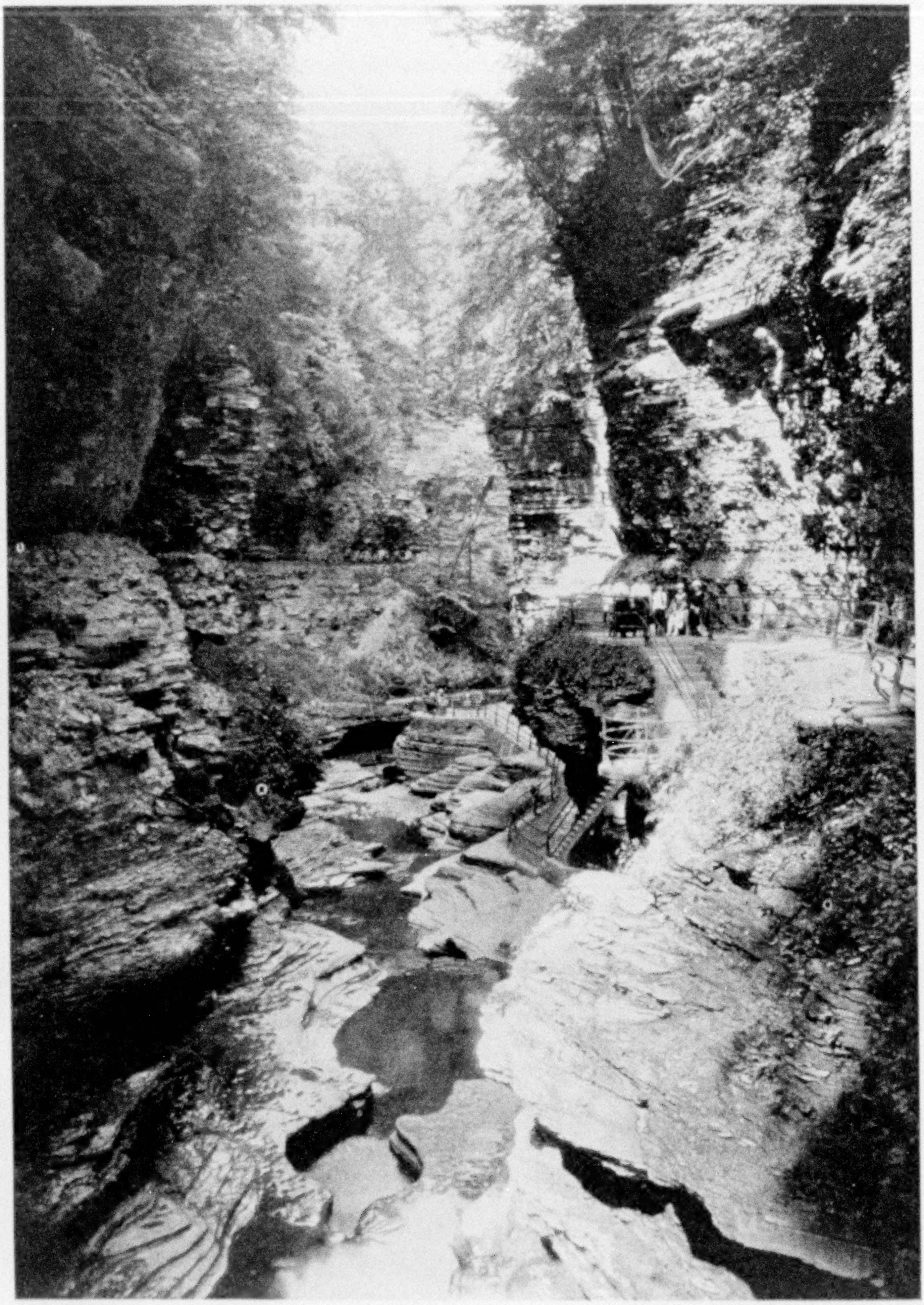
The Monongahela, whose tributary, the New, rises in northwestern North Carolina, and the Allegheny, which has driven its watershed within a dozen miles of Lake Erie, were both lost to the St. Lawrence system when the ice drove the Ohio over the divides at Beaver, Pennsylvania, and New Martinsville, West Virginia (see text, pages 120-121).



Photograph by W. D. Johnson

"SAINT JACOB'S WELL," A SINK-HOLE IN CLARK COUNTY, KANSAS

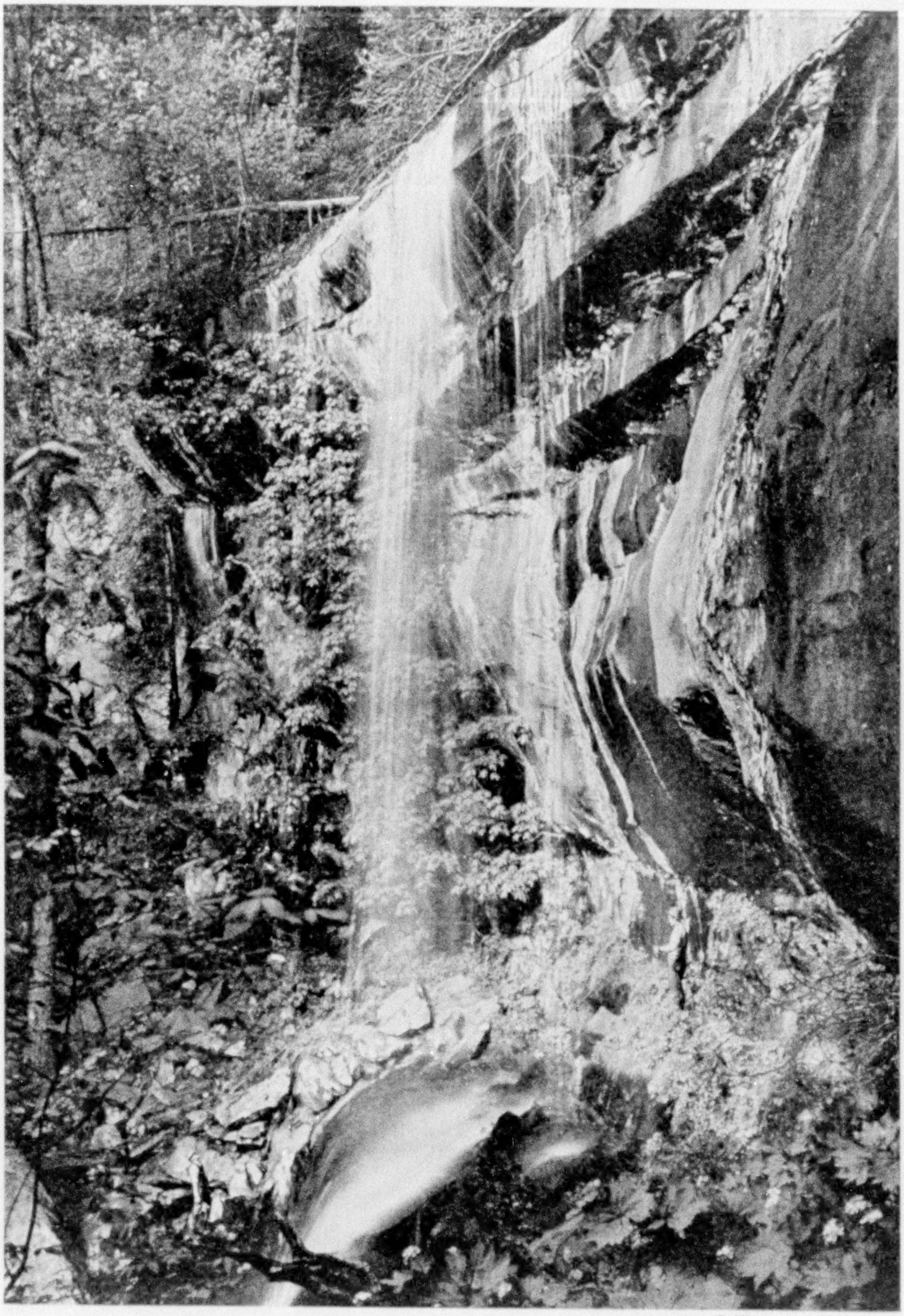
The larger depression, on the rim of which the "well" occurs, is itself a basin of subsidence without outlet.



Photograph by George R. King

WATKINS GLEN, ONE OF NEW YORK STATE'S MOST FAMOUS BEAUTY SPOTS

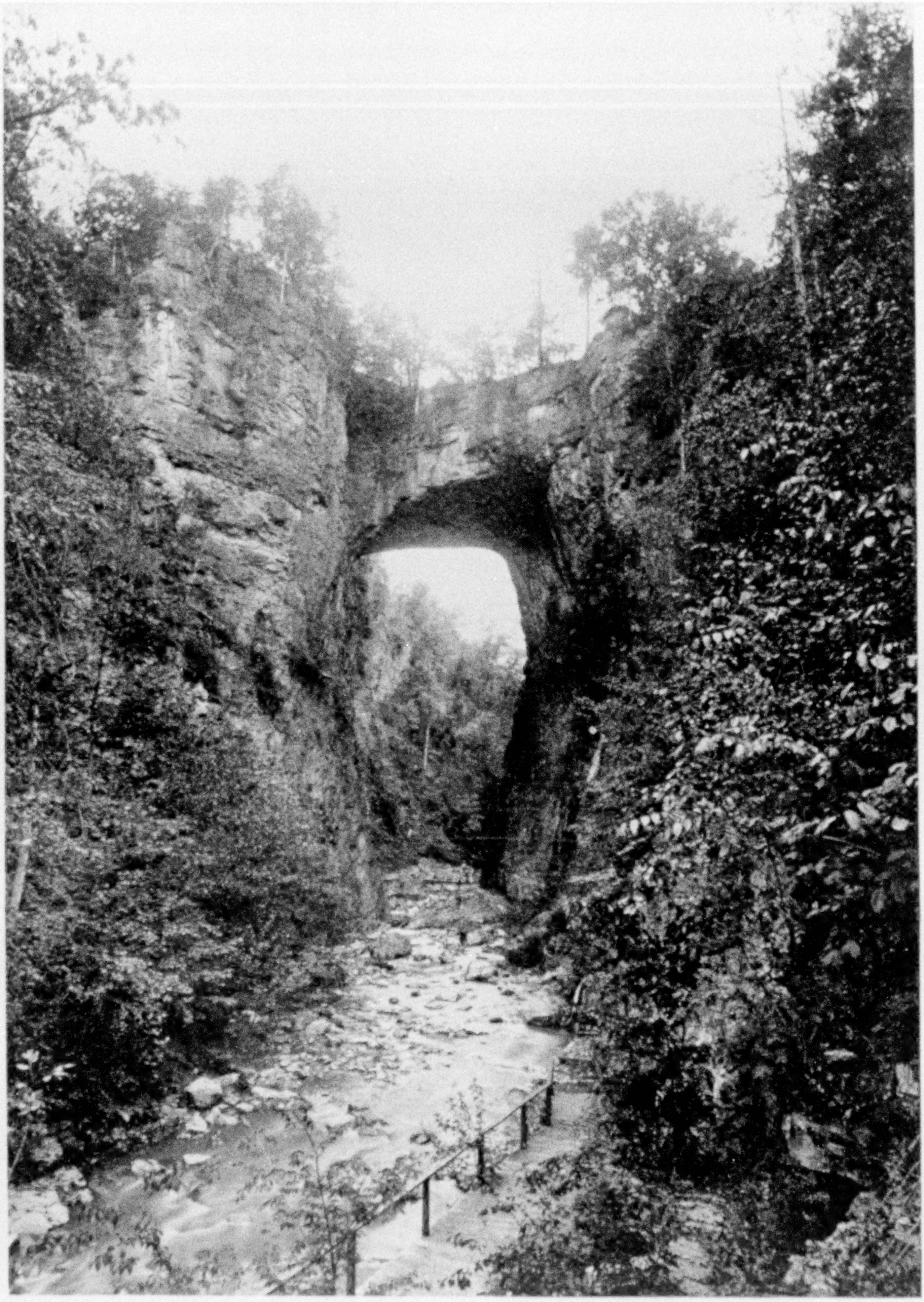
The sculptor of this gorge, which in some places is 300 feet deep, was glacial ice (see text, pages 117, 118, and 119). A narrow stream flows through the ravine in a series of cascades and rapids.



© Thompson Brothers

RAINBOW FALLS, ON THE MILL CREEK TRAIL TO MOUNT LE CONTE, TENNESSEE

These waters are rushing to join the Little Pigeon River, a tributary of the French Broad, one of the most pitiless of buccaneer streams in the Great Smoky Mountains conflict (see text, page 99).



Photograph by Hillers

NATURAL BRIDGE, ROCKBRIDGE COUNTY, VIRGINIA

This impressive monolithic limestone arch, one of the natural wonders of eastern United States, has a span of 90 feet and overhangs Cedar Creek at a height of 215 feet. The limestone is supposed to have covered the gorge completely at one time, and the creek was then a subterranean tunnel.

is gradually digging into the plateau occupied by Shavers Fork, a tributary of Cheat River. Leatherbark Run is an ambitious stream, with a fall of more than a thousand feet in less than a mile and a half, and is now only four hundred yards from one of the tributaries of Shavers Fork. It will not be long, geologically speaking, before it captures its prey, and a falls dropping into a picturesque gorge should mark the scene of the Leatherbark's victory.

THE ANDROSCOGGIN ATTACKS THE CONNECTICUT

The falls at Berlin and Gorham, New Hampshire, are memorials of the time when the Androscoggin River broke through the preglacial divide near the Maine-New Hampshire line, at the foot of Mount Winthrop, and, capturing the drainage of northeastern New Hampshire from the Connecticut River, delivered it into the Kennebec at Bath. When the Androscoggin cut through the divide in order to despoil the Connecticut's preserves, it made an easy route for a railroad, which now shares the pass with the river.

Utah affords another interesting case of this type of lawlessness. The Provo River originally rose on the western slope of the Wasatch Range. Beyond these mountains was the south fork of the Weber, another enterprising stream that formerly had its headwaters on the west slope of the Wasatch, but later succeeded in cutting through and extending its territory into the western end of the Uinta Mountains.

Finally the Provo broke through also, and, attacking the high floor of Rhodes Valley, pushed on until it tapped the south fork of the Weber, thus despoiling that stream of half its water and increasing its own strength correspondingly. This capture was so recent that the entrenching of the stolen stream is still going on.

THE ADVENT OF PASSIVE PIRATES

In the foregoing instances of stream stealing, the rivers and creeks that made the captures were aggressive and daring Brethren of the Main.

There are other streams, however, that have played a more canny rôle. They have craftily laid low and waited until unsuspecting Nature should drive the quarry into their grasp.

One of the most effective aids of these passive privateers was the great ice sheet that thousands of years ago swept down over the northern part of the United States. It covered Long Island, northern New Jersey, the northeast and northwest corners of Pennsylvania, and then swept on westward through Ohio, Indiana, Illinois, Iowa, and the Dakotas to the Rockies.

Prior to its advance the rivers within its limits were different in aspect, direction, and location from what they are today. Many of them were entirely obliterated or forced into new beds; others had their direction of flow reversed and were obliged to pay tribute to stronger streams.

The great Ice Age was indeed a dramatic period in American geological history. Rivers that had flowed north were forced to abandon their outlets and seek others southward; animals that lived in the north were driven southward, and the whole area was transformed by the onsweeping hand of destiny.

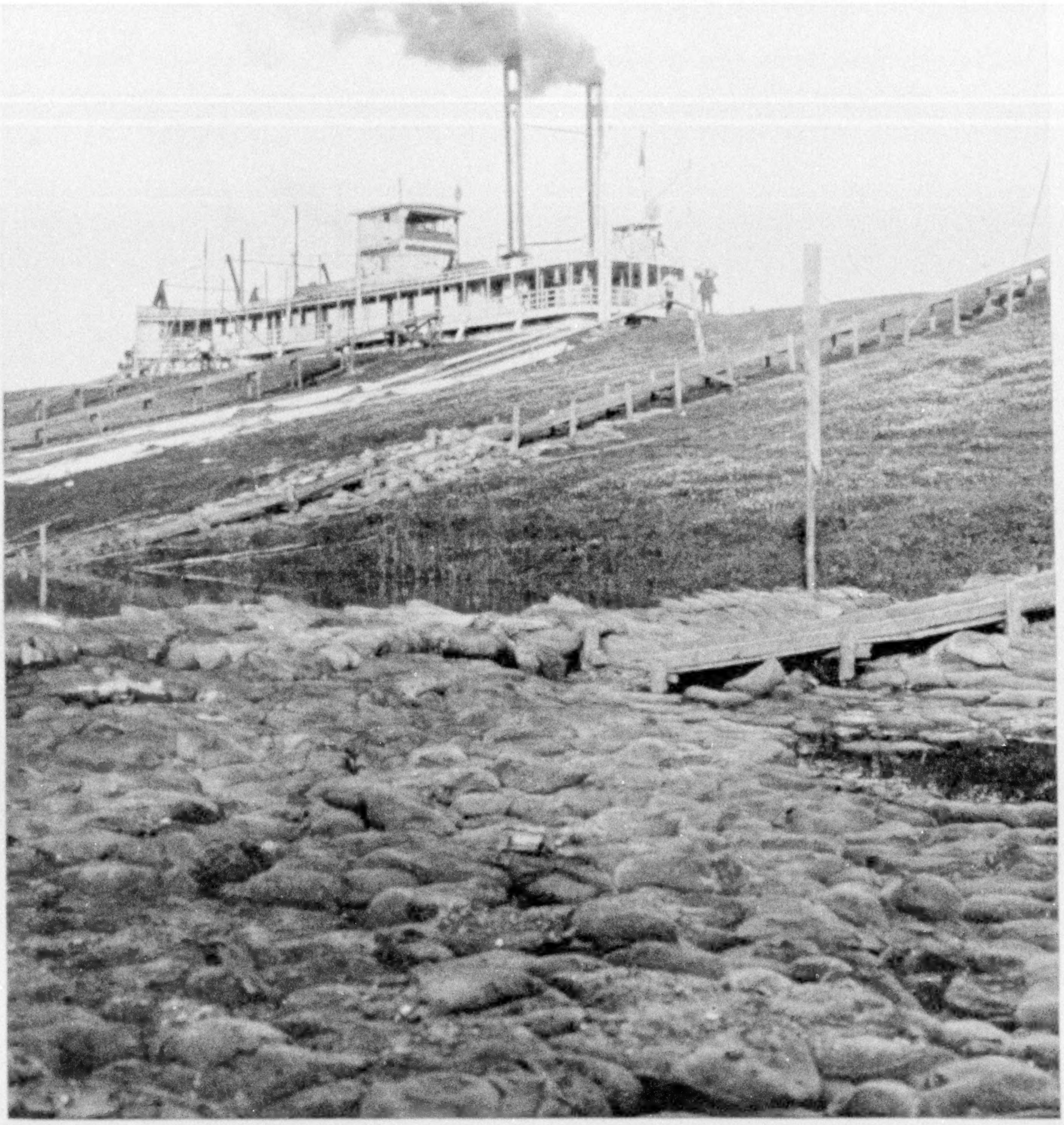
WHEN THE ICE SHEET BEGAN TO RETREAT

The highest point on Mount Desert Island was covered by the flood of ice. Mount Washington probably had only the tip of its summit above the surface of the glacier, which also passed over the Green Mountains where they are upward of 3,000 feet high.

Mount Tom, Mount Monadnock, Mount Holyoke, and the Berkshire Hills all slept beneath its icy sheet. The Catskills were barely able to hold their heads above its onrush, and it left its mark on the summit of Elk Mountain, in Susquehanna County, Pennsylvania.

With our knowledge of the great ice gorges that frequently occur to-day in such rivers as the Susquehanna, the Delaware, the St. Lawrence, and the Missouri, we may well imagine what this mountainous invader from the north did as it advanced, and what floods it crested when the returning warmth melted it away.

The Mohawk River is a classic example of how pirate streams gained rich prizes without aggression at this stage of earth affairs. Before the ice invasion, the ancient Mohawk rose at the head of a di-



Photograph courtesy U. S. War Department

WHERE ONE GOES UP TO THE MISSISSIPPI

In its lower reaches the Mississippi has become so feeble that it can no longer carry off all the sand and silt its tributaries and upper stretches bring to it. Hence it is gradually filling up its own bed, and but for man-built levees would spread its sluggish self over millions of acres of land. How long engineers can go on building up its banks as it fills up its bed is a question often asked, but not yet successfully answered.

vide at Little Falls and flowed westward as a confluent of the preglacial St. Lawrence. At the same time a tributary of the Hudson had worked its way up to the east side of the Little Falls divide. Bed rock to-day slopes westward and eastward from that point (see map, page 92).

In its course southward the ice blanket dammed up the St. Lawrence and the Mohawk alike, and the waters were all driven south through the Mississippi, the Ohio, the Susquehanna, and kindred streams.

Then the ice began to melt, the front gradually retreating northward. Finally, the valley of the Mohawk was uncovered, and it received tremendous floods of glacial water which ultimately drowned the river and converted its valley into a lake. Higher and higher the deluge rose, finally finding the weak spot in the shoreline at Little Falls.

Photograph by Talmage

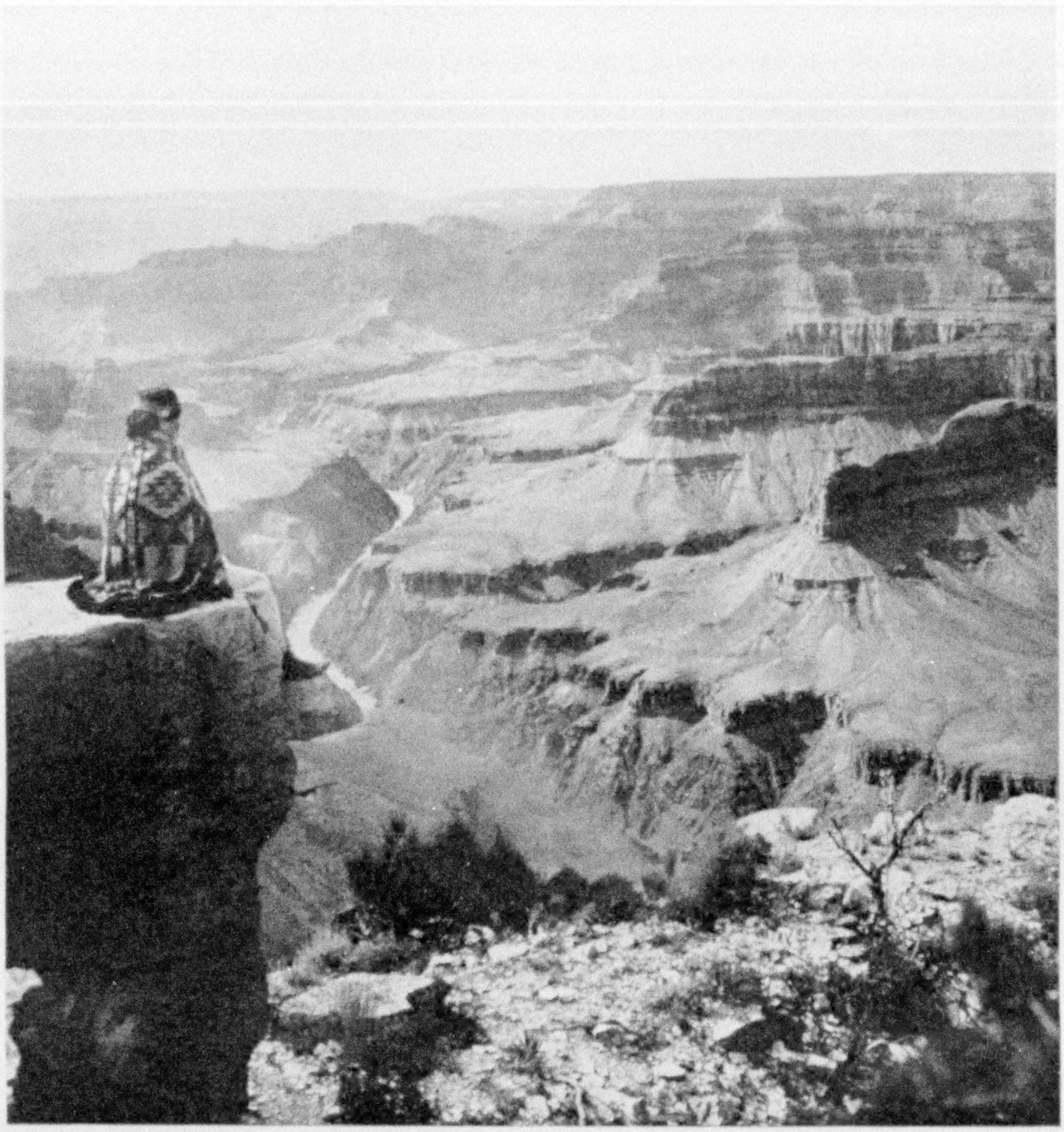
PREPARING FOR A 60-FOOT DIVE: TURNER FALLS, OKLAHOMA

Headwaters of streams often cut through mountains themselves to prey upon other rivers. At other times they capture parts of the water of other streams without invading the streams themselves. For instance, the high peaks of the Teton Mountains of northwestern Wyoming all lie east of the water parting, or actual divide. The rivers flowing east have a more rapid descent than those flowing west, and therefore are gradually forcing the actual divide westward. Given sufficient time, they will be able to eat their way through the Rockies, even as the tributaries of the Tennessee force their way through the Great Smokies (see text, page 99).

Rushing through this saddle in the divide, it fell into the tributary of the Hudson, a gift from the gods. With this vast new accretion of power, the Hudson's affluent began to tear away the vitals of the divide in deadly earnest, and before the ice front had retreated far enough north to uncover the St. Lawrence, had entirely destroyed the barrier between it and the ancient Mohawk and had hoisted its flag permanently over the territory of the latter stream.

Meanwhile the Susquehanna, attracted by the rich spoils the Mohawk Valley offered, had pushed its headwaters within eyeshot of the ridge on the south side of the Little Falls gorge. But the Hudson carried the day and has held the prize throughout the intervening ages.

The battlefield at Little Falls, where the capture was made, is a striking place for such a tragedy. The high and rugged ridges that mark the valley gradually close in as one travels eastward from Herkimer, until they come so close together at Little Falls that there is room enough



Photograph by H. T. Cowling

THE GRAND CANYON OF THE COLORADO

Majestic cathedrals and temples have been carved by the hurrying river, threading its way through the great Kaibab Plateau.

only for the river, the Erie Canal, and the New York Central lines. Shortly after passing that point they separate again and the valley grows wider.

THE OHIO A CANNY CORSAIR

The Ohio captured and has held streams driven into its grasp by the advancing ice. Before the coming of the Ice Age that river had its headwaters near New Martinsville, West Virginia. In those days all of the present drainage of that stream north of New Martinsville flowed into Lake Erie. The Monongahela joined that part of the Allegheny south of Thompsons Gap with its confluents, as now, at Pittsburgh, and, avoiding the present elbow in the Ohio at Beaver, flowed past Youngstown into Lake Erie near Conneaut, Ohio, through a now extinct river variously called by geologists the Grand, the Spencer, and the Pittsburgh.

The advance of the ice sheet dammed back these waters, which, looking for a point of escape, reversed a little tributary whose headwaters were opposite those of

Photograph by W. Cross

FLOWING ROCK IN SILVER BASIN, COLORADO

The high cliff, attacked by the air, slowly crumbles, and the great deposits of talus acquire slopes too steep for stability, and a stream of rock begins to wend its glacierlike way toward the stream that drains the area.

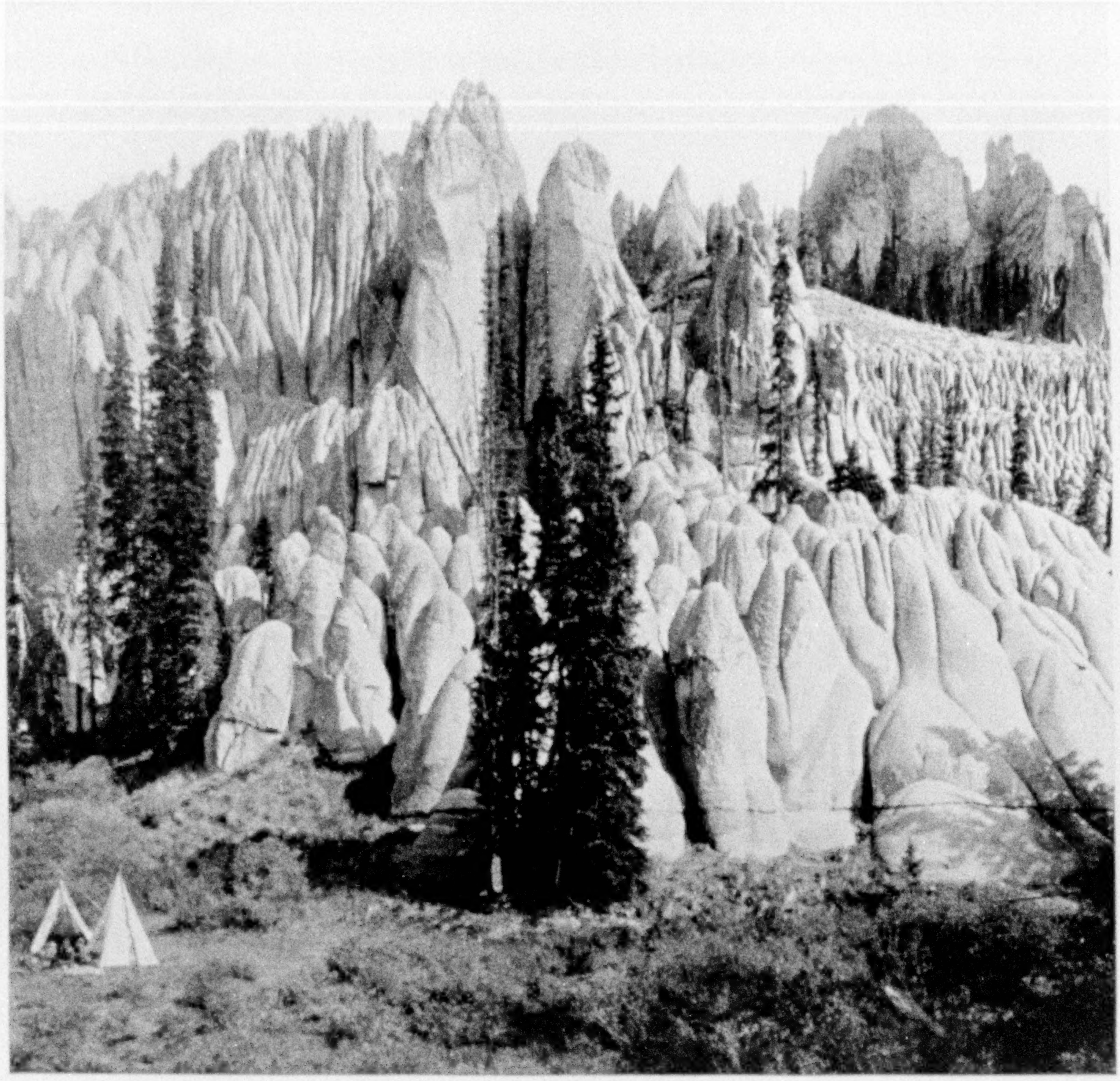
the Ohio at New Martinsville. At the latter point they overflowed the divide and joined the Ohio.

As in the case of the tributary of the Hudson, once the Ohio had succeeded in getting momentary control of the magnificent host of waters the ice had driven into its lair, it worked with terrific energy to hold them.

Its campaign was successful, for when the ice floods were stayed it held the gorge at Beaver and was able to swing the waters of all the captured streams around the elbow at that point and lead them southward past New Martinsville.

It also held possession of all the territory up to the present-day divide that lies hauntingly close to Lake Erie. Indeed, near Dunkirk, New York, one may stand at the parting of the waters between Lake Erie and the Gulf of Mexico and look down into the lake itself.

That part of the Allegheny River above Thompsons Gap was once a northward-flowing stream, with its headwaters on the north slope of the divide at that point. The ice sheet that aided the Ohio had perhaps somewhat earlier aided the lower Allegheny by damming back the north-bound waters and forcing them across the divide into the very lap of the Allegheny. That river accepted the prize and led it



Photograph courtesy U. S. Forest Service

THE "GHOSTS" OF THE RIO GRANDE NATIONAL FOREST

These unique products of earth sculpture in the Wheeler National Monument, which is embraced in the Rio Grande National Forest, convey some idea of the tricks the wind and the water play when they turn aside from their routine task of "exalting" valleys and laying mountains and hills low (see text, page 93).

away in triumph, little dreaming that in its own time it was destined itself to be brought under the yoke of a more powerful stream. By these successive conquests the waters of Chautauqua Lake and the drainage of Olean and Salamanca became a perennial tribute to the Ohio.

THE MISSISSIPPI A POOR PIRATE

Although the Mississippi essayed the same rôle as the Mohawk and the Ohio, it was unable to retain the riches the ice sheet had driven into its fold. The wealth of these waters was unimaginably great. Lake Winnipeg to-day is but a feeble reminder of its once greater self, Lake Agassiz, which covered 110,000 square miles of territory and drained into the Mississippi. Its surface was 15,000 square miles greater than the aggregate area of the Great Lakes to-day.

The advancing ice had closed its outlet to Hudson Bay and had driven its surplus waters over the Big Stone-Lake Traverse divide into the Mississippi. Likewise, the St. Lawrence and the Mohawk were covered, and the drainage of the then much larger Great Lakes was added to the Mississippi's gift at the hands of the ice.

That the floods which surged down the

© Asahel Curtis

PACK TRAIN ON THE SWITCHBACK ABOVE HOLLAND LAKE, MONTANA

Lakes are, with few exceptions, arrested streams. Compared with rivers, their tenure of life is amazingly short. The former beach lines of the Great Lakes show that they are all drying up. Lake-studded landscapes are invariably youthful.

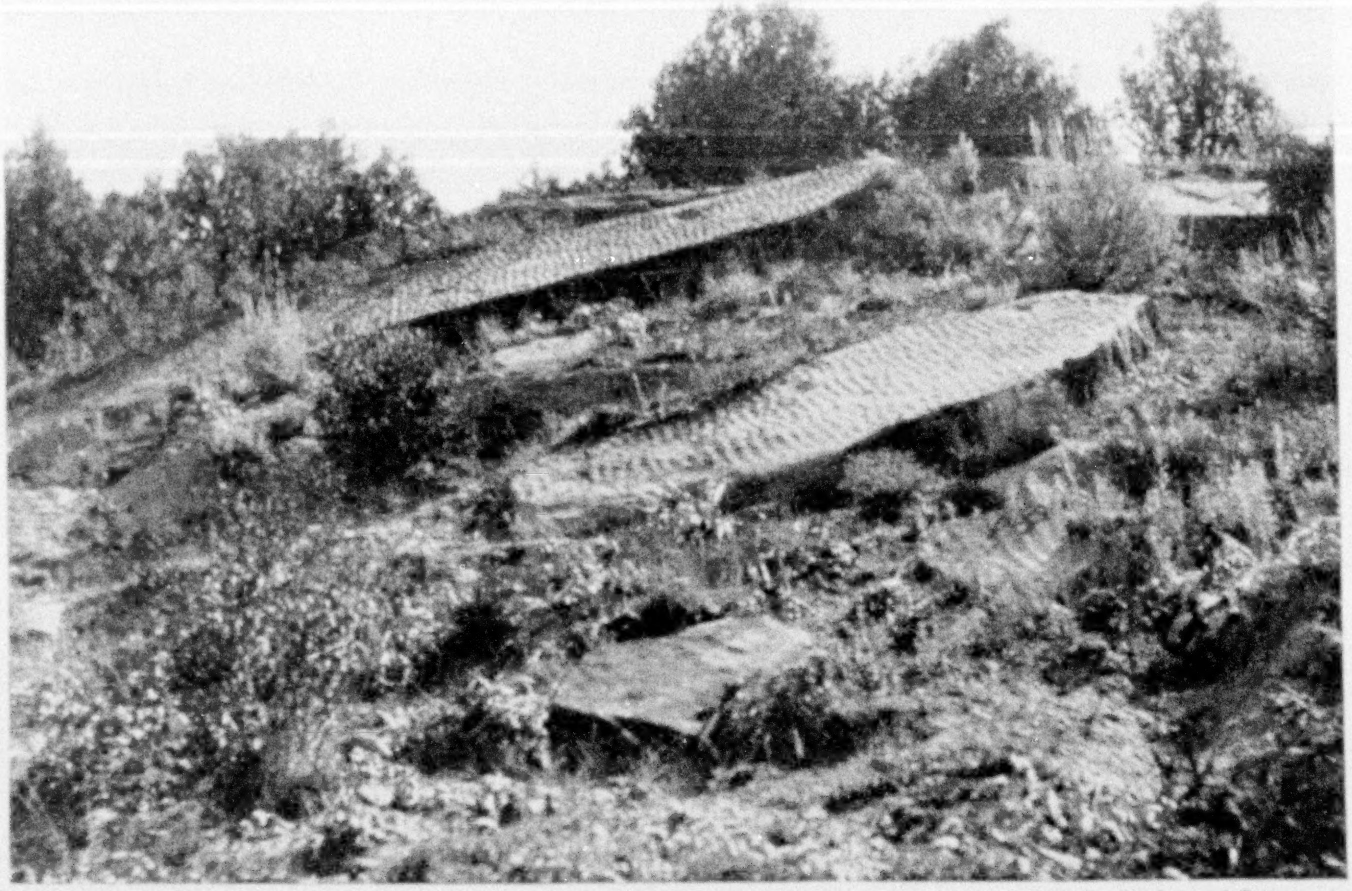
Father of Waters at that period were unbelievably vast may be gathered from a study of the inner Mississippi Valley above St. Louis. Though its width is from 5 to 10 miles, one finds terraces of glacial gravel as much as 200 feet above the river's present flood plain. These terraces represent the high watermark of the tremendous closing floods of the reign of ice.

THE RED RIVER OF THE NORTH REGAINS ITS OWN

Unable, however, to plow down the preglacial divide which formerly separated the waters of the North from those of the South, the Mississippi after the retreat of the ice could no longer hold those it had temporarily acquired.

And so the Red River of the North, drowned and obliterated during the reign of ice, began to come back into its own, lengthening its reaches as the shores of Lake Agassiz retreated.

To-day Big Stone Lake and Lake Traverse mark the place where the Mississippi lost control of the great Lake Agassiz drainage. And by so narrow a margin was it lost that even to-day the direction of the wind often decides whether certain waters shall find their way into the Gulf of Mexico or into Hudson Bay.



Photograph courtesy U. S. Geological Survey

SANDSTONE RIPPLES, A RECORD WRITTEN BY WATER IN MOTION

In numerous epochs much of the State of Colorado lay beneath the waves of invading seas, but these ripple-marked sandstone rocks, to be found in the heart of the Rocky Mountains, may have been made by a stream. They resemble wind ripples on a desert floor.

Just as the Ice Age compelled the Mohawk to open up the divide at Little Falls and gave the Erie Canal a route to the Hudson, so, forcing the waters of Lake Agassiz out over the vast valley of the present Red River of the North, it laid down the soil for the world's most magnificent wheat fields on both sides of the International Boundary.

The present Mississippi above St. Paul is a comparatively recent stream, occupying a postglacial bed. The trough of the Minnesota represents the Mississippi Valley of glacial times, and that of the Red River of the North is but its northern continuation. The valley of the Minnesota is from one to four miles wide and its rocky bottom more than 150 feet below the present bed of the stream—a valley out of all proportion to the comparative insignificance of the watercourse that meanders through it.

In the Glacial Era that valley carried the floods of the Lake Winnipeg basin, while the St. Croix gave outlet to those of the Superior basin, and the Illinois took care of those of the Michigan-Erie-Hudson basin.

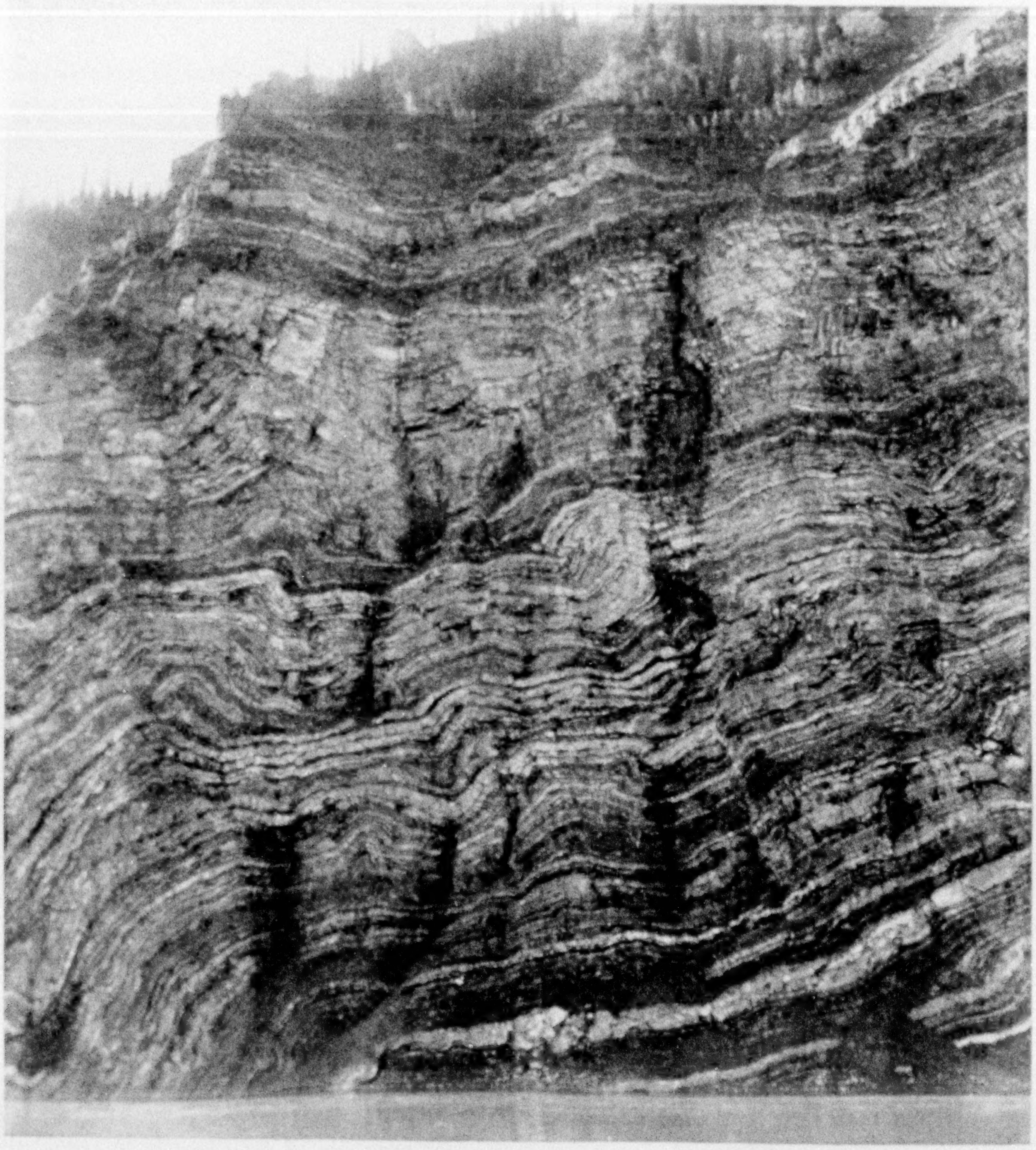
But these lakes all acted as settling reservoirs and delivered so little sediment to their draining rivers that the latter were unable to tear down the divides. Hence it was that when the ice drew back its lines the channels of the draining rivers were not deep enough to hold the waters they had captured.

THE MISSOURI DRIVEN OUT OF ITS BED

The Missouri River and its tributaries were apparently forced out of much of their ancient beds by the advance of the ice. There is some evidence that they may have previously poured their waters into Hudson Bay through the ancient Red River of the North.

Yet into whatever basin they drained in those days, they now occupy, for the most part, beds that were not theirs before. The direction of the upper Missouri, the Little Missouri, and the Yellowstone is toward a common point in North Dakota.

Whatever the original course of the



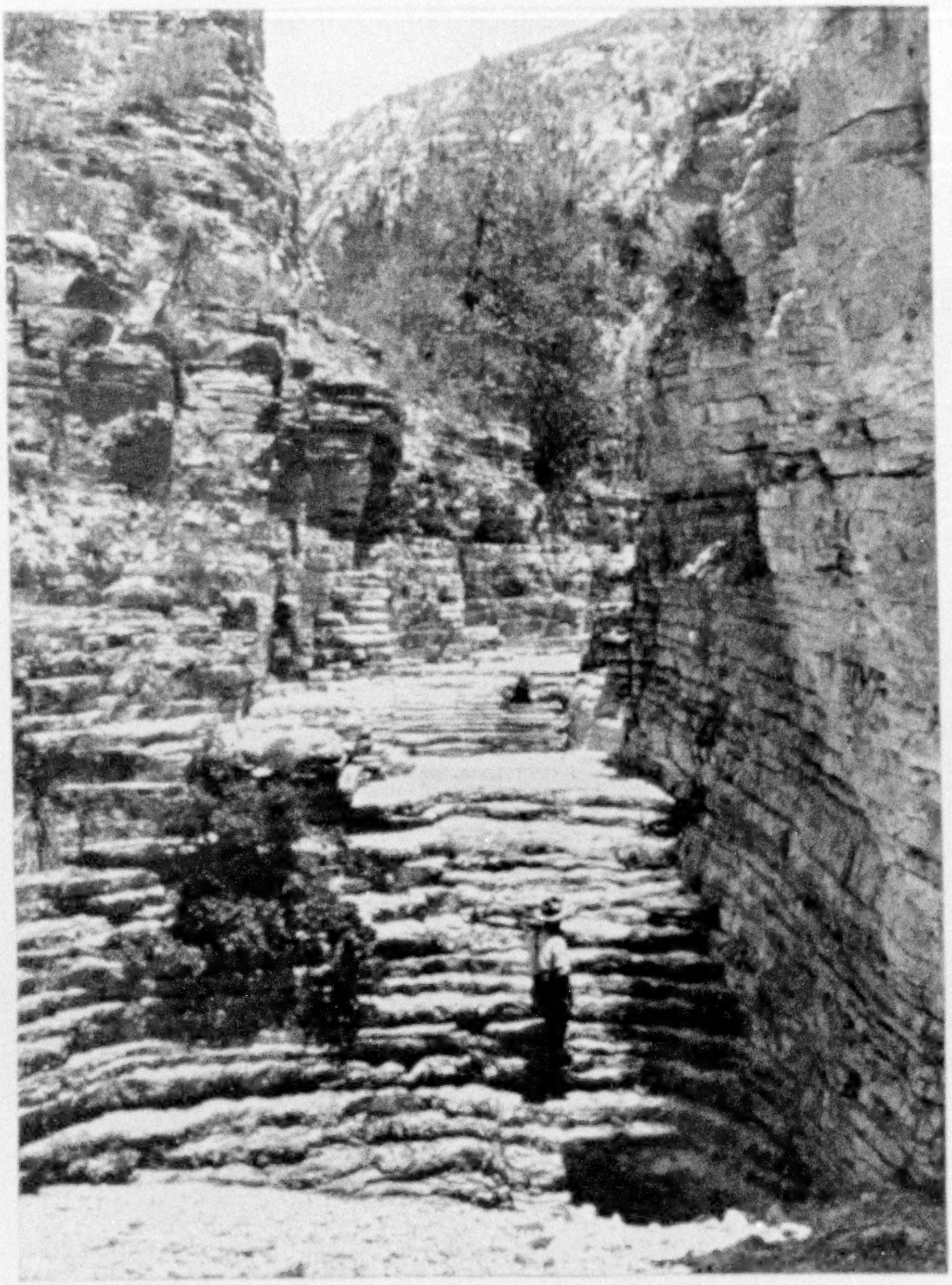
Photograph courtesy U. S. Geological Survey

CALICO BLUFF ON THE UPPER YUKON RIVER NEAR TANANA, ALASKA

In cutting its way to the sea, the Yukon has sawed into strata of rock representing eons in their making. With its intricately folded rock, Calico Bluff gives a slight hint of the "growing pains" of Mother Earth in the past.

Missouri above the big bend that turns its direction of flow from east to south in North Dakota, it is certain that it did not run where it now does. The glacial wall, advancing across its original valley, scraped off the tops of the hills and filled in the valley with the débris. Thus driven out of its fine primeval bed, the river began to dig in along the base of the ice wall, and presently had its channel sunk so deep that it has been able to hold it ever since.

A notable eastern example where a river has been driven out of a portion of its bed by the ice invasion and successfully reresisted capture by a neighboring stream of pirate proclivities is the Chemung, in the neighborhood of Big Flats, Horseheads, and Elmira, New York. Flowing from the west, it met the ice upstream from Horseheads, and was forced to give up its channel and to take a narrow valley behind a long, high hill, en route to Elmira (see map, page 92).



Photograph by Jacob Gayer

THE STAIRS OF PINE CANYON: GUADALUPE MOUNTAINS, TEXAS

Each stratum a little softer than its lower neighbor, the floor of the canyon is worn down like the stairs of a Brobdingnagian palace.

The flood waters of the melting ice brought down a vast amount of glacial gravel, which filled the Chemung's abandoned valley, leaving there to this day one of the world's finest examples of an overwash plain.

In the same general region one finds that the glacial drift choked the valley through which ran the stream that drained Lake Cayuta into Lake Seneca, through which its surplus reached the St. Lawrence. The obliteration of this valley drove the Cayuta's overflow into the Susquehanna, which has held it ever since.

The rise and fall of sections of drainage areas n the crustal movements on the earth's surface have been as notable a first aid to passive pirate rivers as was the advance of the great ice sheet. Ordinarily one thinks of these oscillations as taking place in the long ago; but they are always going on, though usually with such imperceptible slowness that they practically defy detection.

A rise or fall of even a thousand feet would mean a variation of far less than a hair's breadth in the biggest globe the map-makers build, while much less than a thousand-foot variation has served many an ambitious river gloriously.

Old beaches, dry valleys, marine deposits on mountain tops, and river trenches in the continental shelves—all proclaim these fluctuations in the past, as do youthful valleys in old landscapes.

A subsidence of 500 feet would cause the Gulf of Mexico to drown St. Louis and would put Boston, New York, Philadelphia, Baltimore, Washington, and Charleston beneath the waves of the Atlantic Ocean.

THE SHIFTING OUTLETS OF THE GREAT LAKES

Ice and changing slopes of the earth's crust joined forces in driving the waters of the present Great Lakes region into the control of the St. Lawrence. However, before these forces finally left the Lakes under the jurisdiction of that international stream they had dispatched their waters first one way and then another.

It is generally believed that before the advent of the Ice Age none of the present Great Lakes existed, but that the St. Lawrence, the Mississippi, and probably a Hudson Bay-bound river shared the territory from which they draw their waters.

At various periods the Lakes changed their connections with one another and shifted from one outlet to another. At one time Lake Superior's water level was 500 feet higher than at present, its drainage being into the Mississippi through the Bois Brulé and the St. Croix. We have already seen how, at another stage, the Lakes found an outlet through the Mohawk (see text, page 117).

Likewise the former greater Lake Michigan found an outlet at one time through the Illinois River, and simultaneously, or some time during the same era, gave the Wabash a chance to share in the spoils.

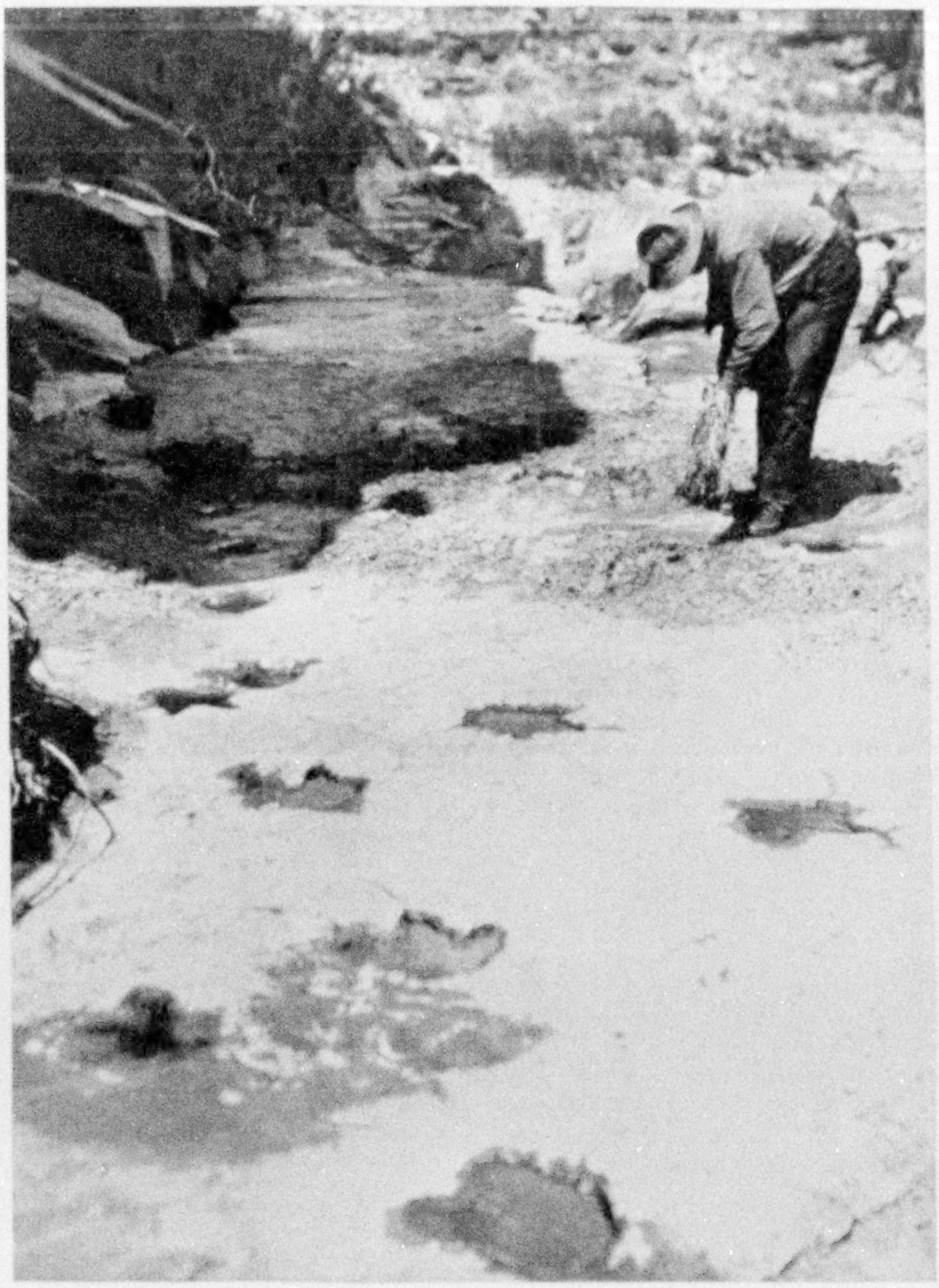
With the retreat of the ice, the Lake Erie-Lake Ontario basin was divided and Niagara River began to flow. Its further retreat uncovered the Trent River valley, and the drainage of the upper Lakes passed directly through that to Lake Ontario, ignoring Lake Erie, and consequently reducing Niagara River to a small stream.

MANY VICISSITUDES IN THE CAREER OF NIAGARA RIVER

But then the land level began to rise in the vicinity of the Trent outlet; presently the outflow went back to Detroit, and Niagara River came into its own again.

Then there came a sinking of the land at Nipissing Pass and in the Mattawa and Ottawa River valleys, and once more the Detroit River ran dry and Niagara River grew small. The Ottawa now carried the waters of the upper Lakes into the Gulf of St. Lawrence. The elevated beaches around Lake Nipissing show that the Ottawa held this drainage for a very long time.

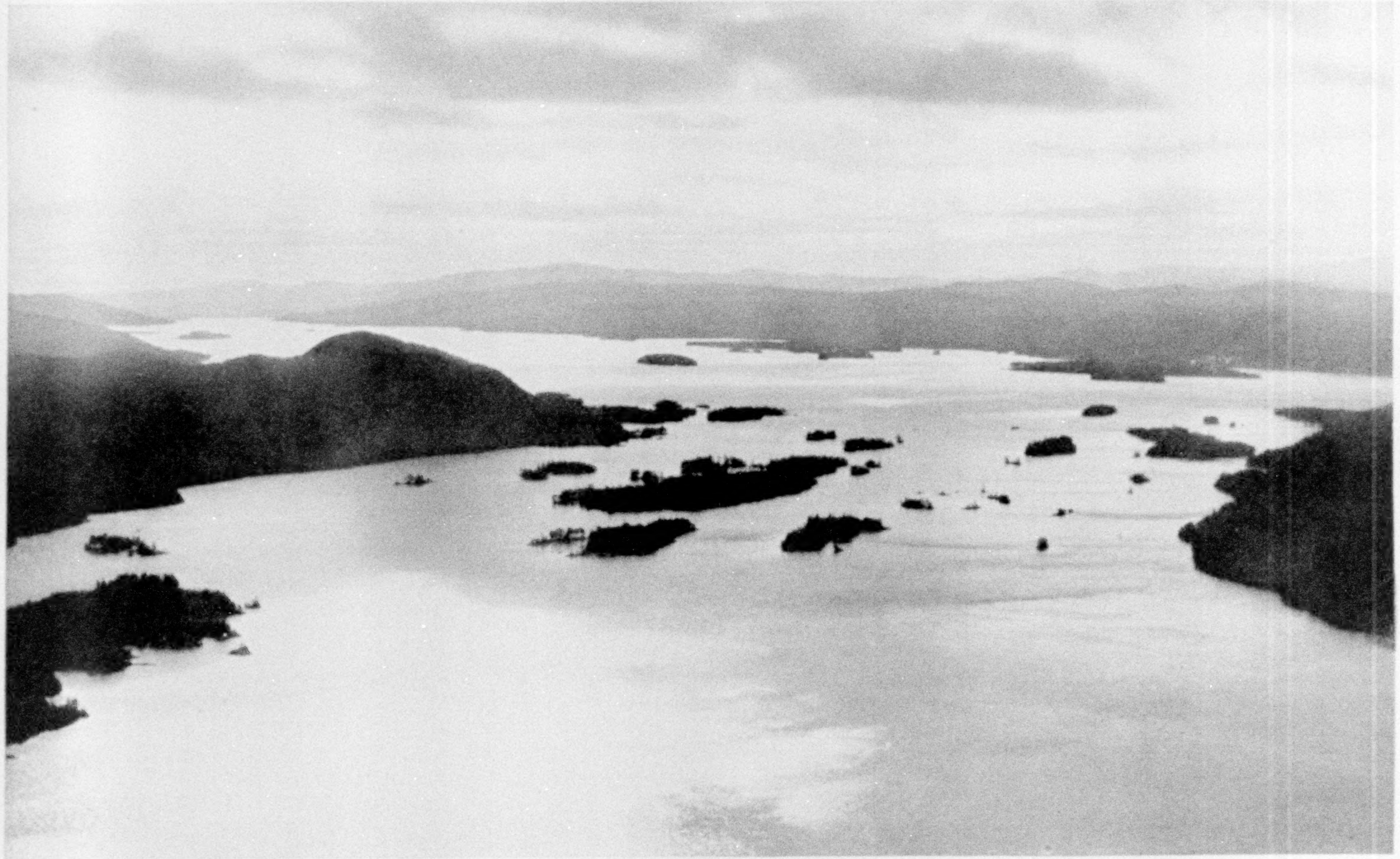
Another change in surface level brought the discharge of all the Lakes into Niagara River, and with it a new form of piracy, the capture of one cataract by another. It is generally believed that at first



Photograph courtesy U. S. Geological Survey

DINOSAUR TRACKS TURNED TO STONE IN NAVAJO CANYON, ARIZONA

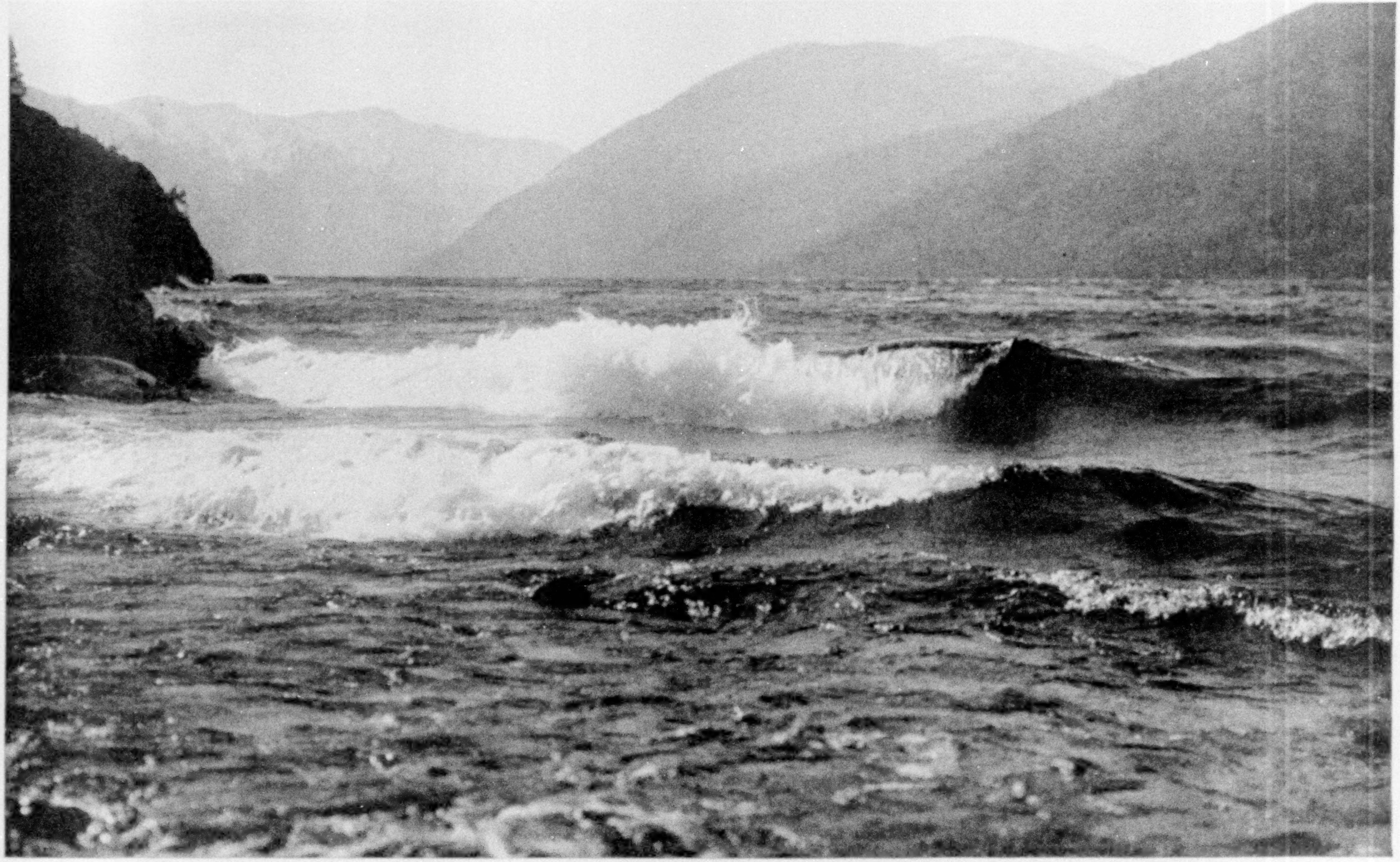
Rivers have prepared the silt and the sand as graves and coffins of millions of creatures of the past and preserved them.



© Major Hamilton Maxwell

ISLAND-STUDDED LAKE GEORGE: NEW YORK

Geologists regard this sister of Lake Champlain as a river valley whose ancient outlet was clogged by drift deposits, and whose floor was planed down by ice erosion. Its irregular form is due to the invasion of tributary valleys by the impounded water, forming bays and straits in the lowlands, and islands, peninsulas, and isthmuses where the ground was higher.



© L. D. Lindsley

MOUNTAIN-ENCOMPASSED LAKE CHELAN: WASHINGTON

Pierce River loses itself at the head of this largest lake in the Northwest. At the foot it drains into the Columbia River over the Chelan Falls. Some day its impounding barrier will succumb before the unremitting forces of the erosion of its own outflowing water, and another of the world's beautiful lakes will have spent its days "as a tale that is told."

Niagara was something like its general picture at present (see pages 42 and 47), and that later it was succeeded by a series of three falls not unlike those of the Genesee to-day.

After that the three leaps of the water were consolidated into one, which had the general aspect of the present American Fall. Then, when the Falls had receded to the vicinity of the present Foster Flats, a sort of Goat Island appeared and divided the cataract much as at present—only the American Fall played the major instead of the minor rôle. Finally it robbed the Canadian Fall of all its waters, just as the Canadian Fall to-day is slowly gathering in those of its American competitor—a Roland for its Oliver.

The Horseshoe Fall at the present time has taken control of more than 90 per cent of Niagara's flow, but the pirated waters are gradually driving it to suicide by converting the horseshoe into a V.

As the Falls retreat upstream, the underbedding shale drops deeper and deeper, and they will probably reach an ultimate point where they are beyond the attack of falling water. In that event, majestic Niagara may be degenerated into a rapids. But as the march Erieward, even at the apex of the Canadian Fall, is only a matter of a few feet a year, a good many generations of honeymoon couples may still go there before Niagara ceases to be the wonder-inspiring spectacle it is to-day.

WILL NIAGARA AGAIN GO DRY?

There is one earth process now apparently in full swing that may dry up the Falls entirely before they work their own undoing. Delicate surveys show that the earth crust in the Great Lakes region is gradually tilting toward Chicago at the rate of 9 or 10 inches a century. If that keeps up, simple arithmetic tells us that the waters of Lake Michigan will begin to spill over into the Mississippi Valley again in 600 years, and in 3,500 years Niagara will be high and dry once more!

This would allow the Mississippi to resume its Ice Age rôle of a passive pirate and give it dominion over most of the waters of the St. Lawrence. By such means does Dame Nature jest with mankind.

The oceans are as ready as the rivers to commit passive piracy whenever the subsidence of a section of the land permits. A classic illustration of what happens when such a subsidence occurs is to be found in the case of the Susquehanna. Once that river flowed through a fine valley and out to sea between Capes Charles and Henry. Then the floor of the valley subsided and the ever-ready old Atlantic Ocean rushed in and took possession of it. We now call that ocean-conquered valley Chesapeake Bay.

The buried valley of the Hudson, which has been traced out to the very edge of the continental shelf, shows that the Atlantic has taken possession of a great area once drained by that river, because of the sinking of the land.

Nor is the process at an end. Surveys show that the land is still subsiding at the rate of about two feet a century in the vicinity of New York. Vegetation, material eroded by the Hudson and other rivers, and various agencies are at work to counteract the subsidence, but their combined activities have not succeeded in balancing it.

We see the St. Lawrence drowned as far as Montreal and know that Delaware Bay is a submerged section of Delaware River. Likewise, the Gulf of California is the drowned lower course of the Colorado River.

THE LOSING BATTLES WAGED BY LAKES

Geologically speaking, lakes of all sizes, from the small roadside pool to the vast inland sea, are short-lived. Always they are obstructions to the free flow of streams, and the hand of every stream is against them from the very hour of their birth. Every rill brings down its little contribution for the driving back of the shoreline and the filling of the basin, and the sun does all it can to evaporate the waters. The deltas of the Finger Lakes of New York proclaim the power of the former process, and the salinity of Great Salt Lake gives an idea of the latter.

Then, too, there is usually some river busy handing the lake a back slap by digging down an outlet and thus capturing its waters. Of this we have a splendid example in the story of that once majestic inland sea which occupied the great Utah Valley and of which Great Salt Lake and Lake Provo are surviving remnants—Lake Bonneville.

Photograph by Captain A. W. Stevens

THE FERTILE HOOD RIVER VALLEY, WITH MOUNT HOOD IN THE DISTANCE

Throughout most parts of the world thousands of feet of sedimentary rock lie between the soil and the primeval granite. Every foot of this rock is composed of material torn from the adamantine crust, transported as sand and silt, reincarnated as sandstone and shale, only to be reeroded, retransported, and reincarnated repeatedly before it assumed its present form (see text, page 87).

This lake rose higher and higher until it began to overflow into Snake River, which thereupon took on new life and began to attack the point of outflow, finally getting command of the situation and drawing off Bonneville's water.

RIVERS JEALOUS OF THEIR BIRTHRIGHT

No matter how successful lakes momentarily may be in pirating the waters of streams, sooner or later they lose and the rivers banish them from the earth. That is why every new landscape is full of lakes and every old one is all but lakeless.

Except for the limitations of space, one might go on at length with the fascinating story of pirate rivers and of the struggles of streams against every kind of captor that would deprive them of their birthright of access to the sea.

The scene of the New Madrid earthquakes might be visited, where, in 1811-13, the Mississippi River ruthlessly pushed aside the barriers thrown across its path and continued unchecked to the Gulf.*

---

* See "Reelfoot—an Earthquake Lake," by Wilbur A. Nelson, in the NATIONAL GEOGRAPHIC MAGAZINE for January, 1924.

A journey might be made to the Palisades of the Hudson to observe how that river broke through the great lava intrusion and kept its course to the Atlantic.

A pilgrimage to the great lava beds of Washington and Oregon, which cover tens of thousands of square miles to a depth, in some places, of 4,000 feet, would reveal how the Snake River has held to its ancient course in spite of all the efforts of the lava flows to drive it into the camp of some pirate river.

In Alaska one might see how Old Vulcan himself threw a huge heatwelded dam across the doughty Yukon at the confluence of the Pelly and note how the gallant river tore down this formidable barrier in its effort to free itself from the lake that held it captive.

So, too, we might turn to those mighty avalanches of stone which have ruthlessly flowed down the sides of thousands of mountains and across the paths of rivers, only to be pushed aside by waters that would not accept captivity.

Lost rivers and sinking creeks that dot the map of America might also be followed into the ground and watched as they excavate, with silent hands, stupendous caverns in solid limestone and build up magnificent interiors, fit abodes even for Old Pluto himself.

Scores of Beaver Dams in the United States could tell us how even busy little animals have played the rôle of Tom Thumb pirates, attacking Lilliputian rivers and imprisoning them in Toyland lakes.

MAN AS A PIRATE AGAINST RIVERS

Man himself has some piracies against rivers and creeks to answer for. The Chagres might tell how it was led around at his will and forced to carry the ships of the Seven Seas across the narrow backbone of the Western Hemisphere. Strawberry and Gunnison rivers might tell their story of being compelled to abandon their own valleys and to pass through tunnels in mountains in order that Western deserts might become lands flowing with milk and honey.

Even the Tiber and Goose Creek, which once flowed respectively at the base of Capitol Hill and across Pennsylvania Avenue in Washington, D. C., but which are both only a memory now, might tell of man's mastery over many waters.

But our wanderings must end. As we bid farewell to our river friends, let us remember that piracy is not their principal activity, but that, as the sculptors of the world's landscapes, the makers of the world's Edens, the forerunners of every civilization, they have made the geography of every continent what it is and have prepared the earth as a habitation for all things that live.

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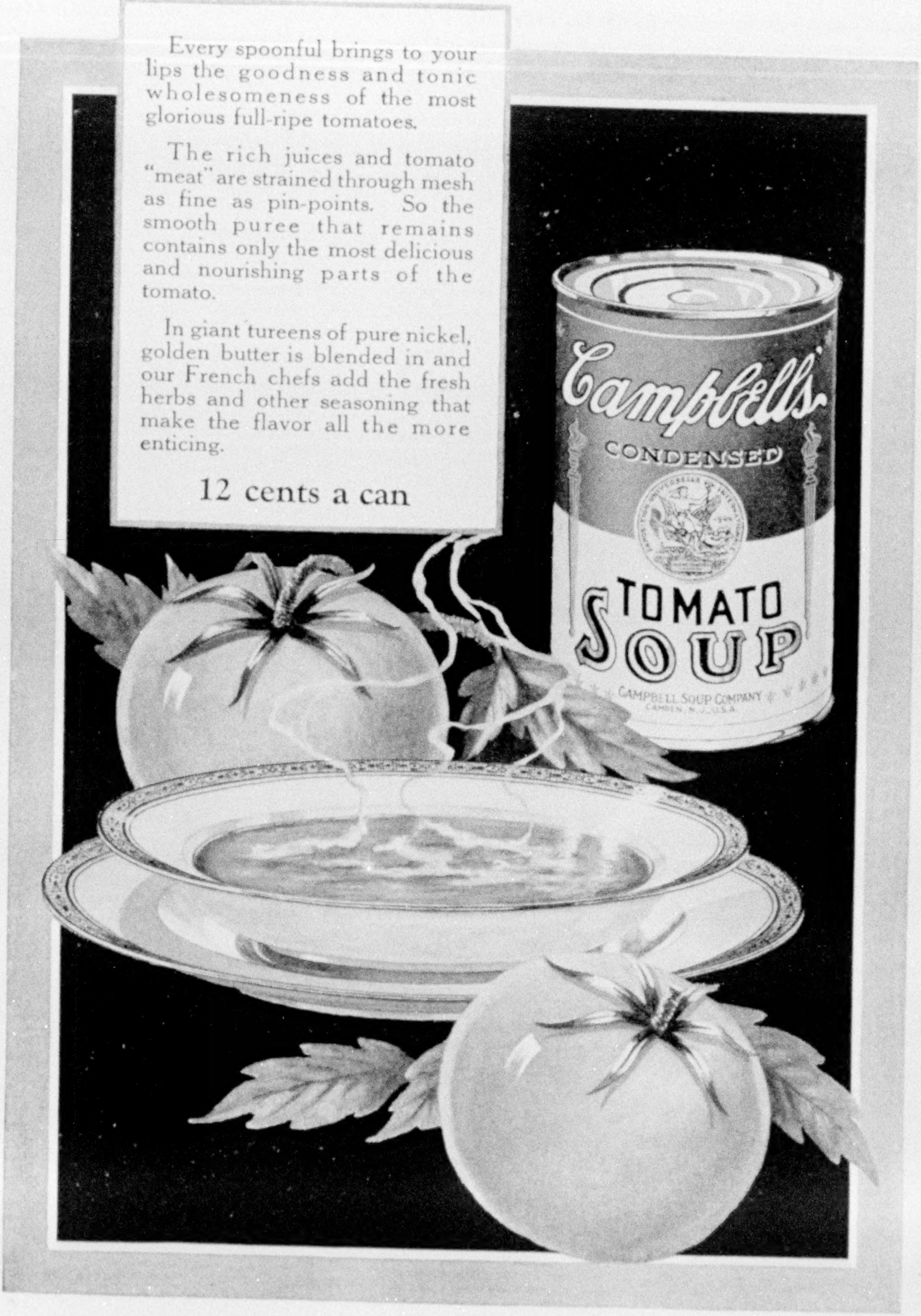
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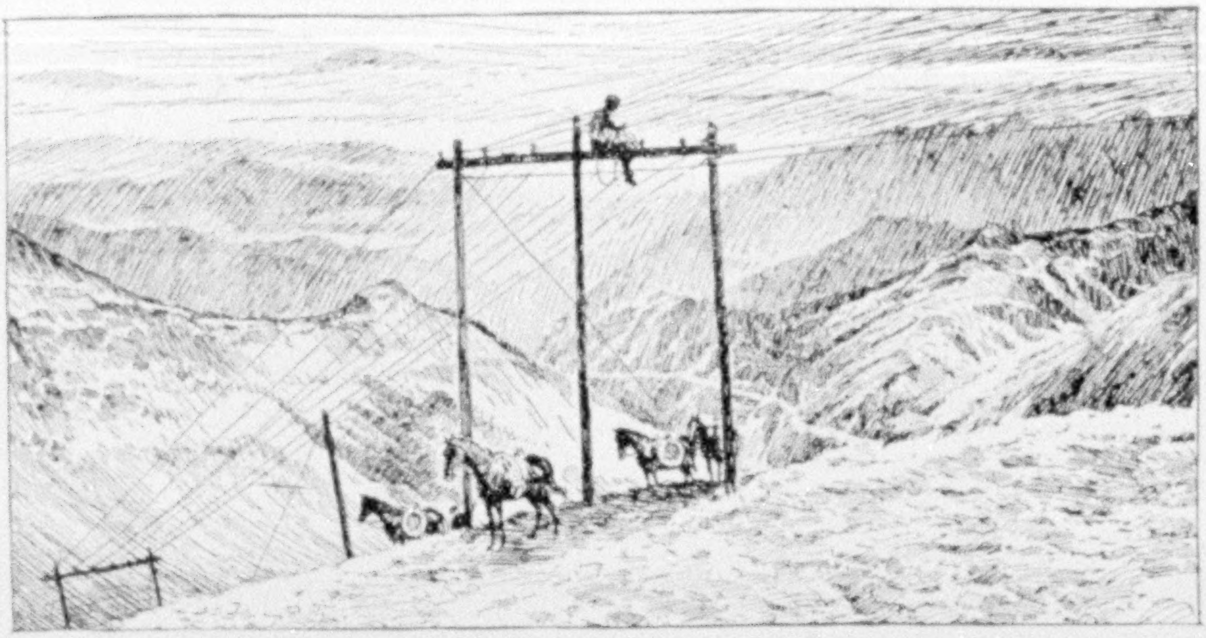

The Builders of the Telephone

Spanning the country, under rivers, across prairies and over mountain ranges, the telephone builders have carried the electric wires of their communication network. Half a century ago the nation's telephone plant was a few hundred feet of wire and two crude instruments. The only builder was Thomas A. Watson, Dr. Bell's assistant.

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Telephone builders are still extending and rebuilding the telephone plant. A million dollars a day are being expended in the Bell System in construction work to provide for the nation's growing needs.

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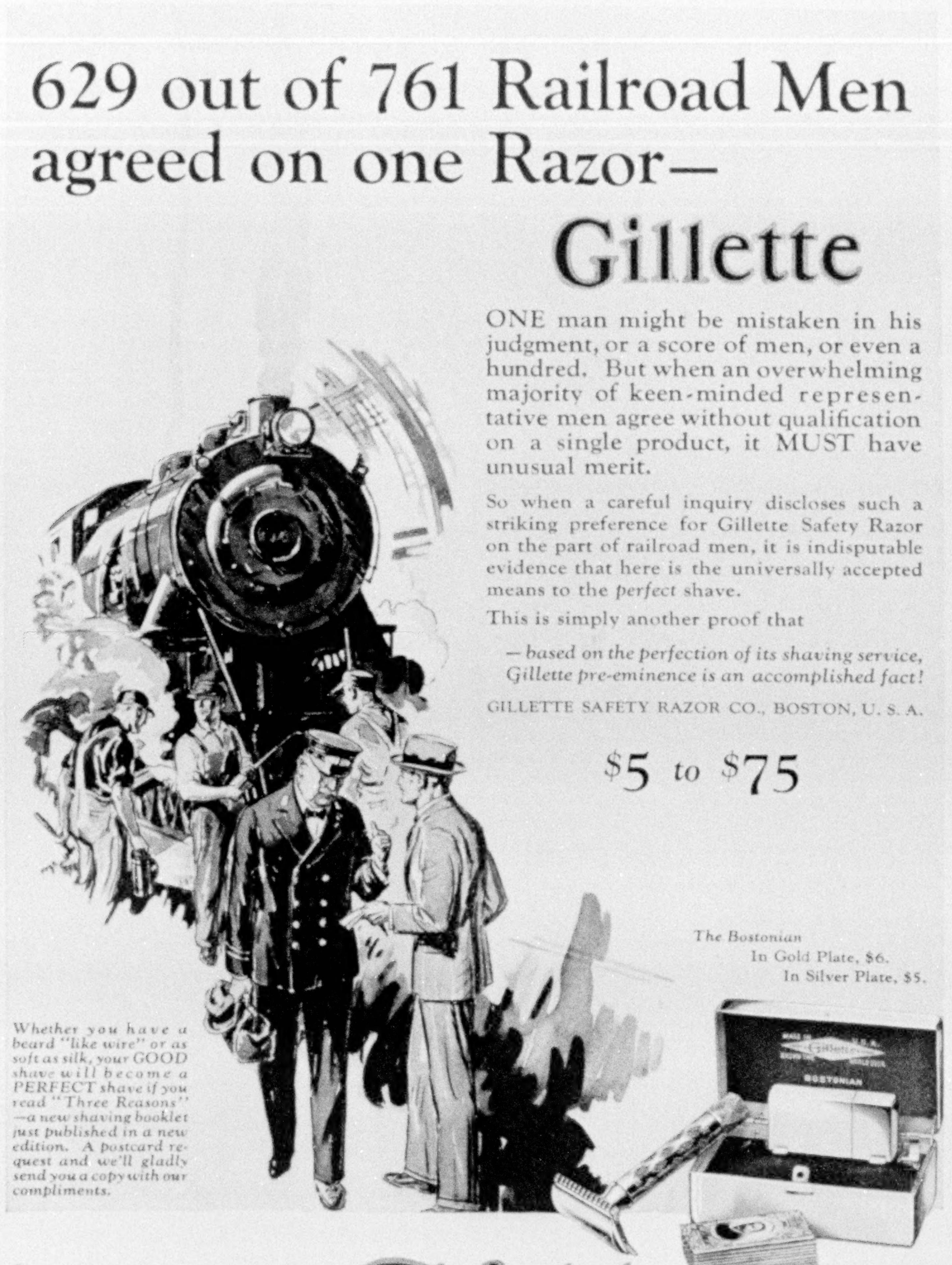

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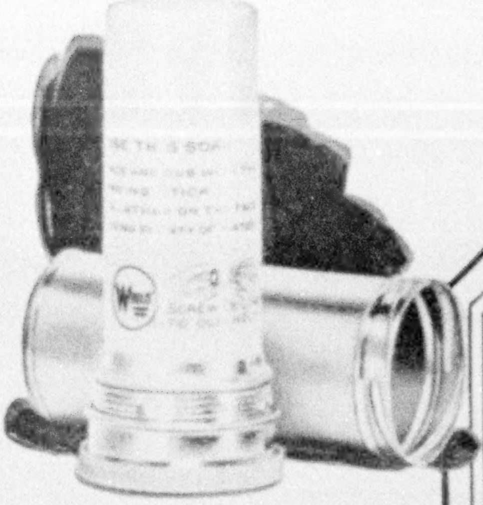

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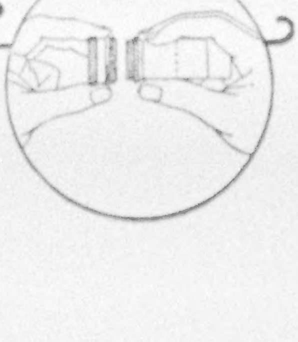

THIS is how the threaded metal ring on the Williams reload screws securely into the Holder Top. The soap can't slip while it's in and when you want to take out the final wafer, it comes out cleanly without muss.

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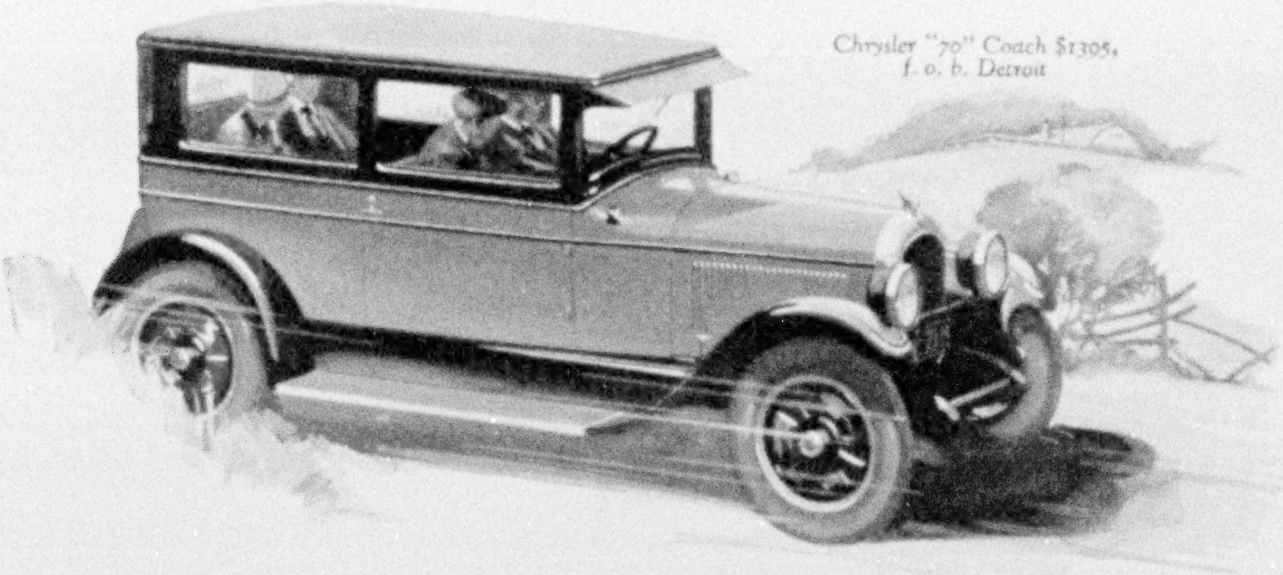

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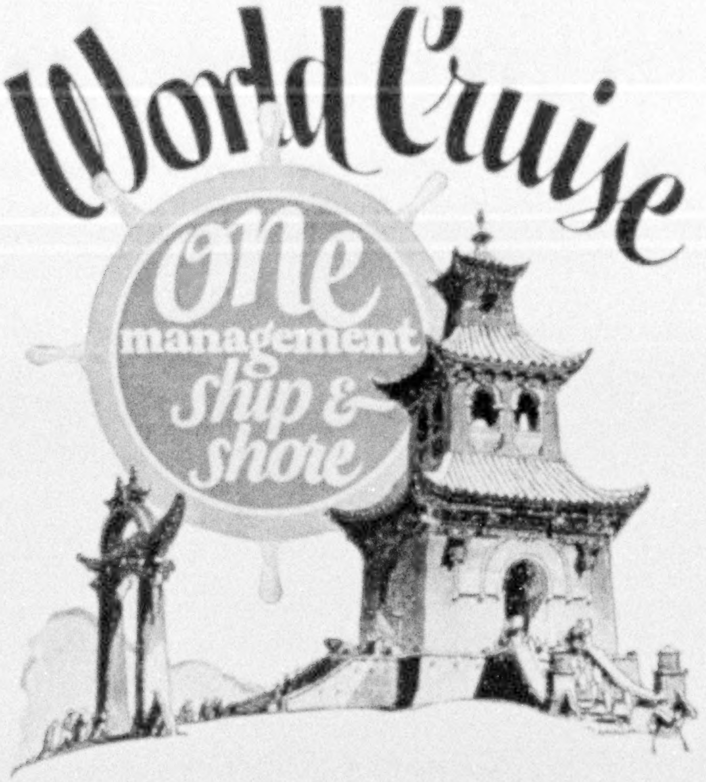

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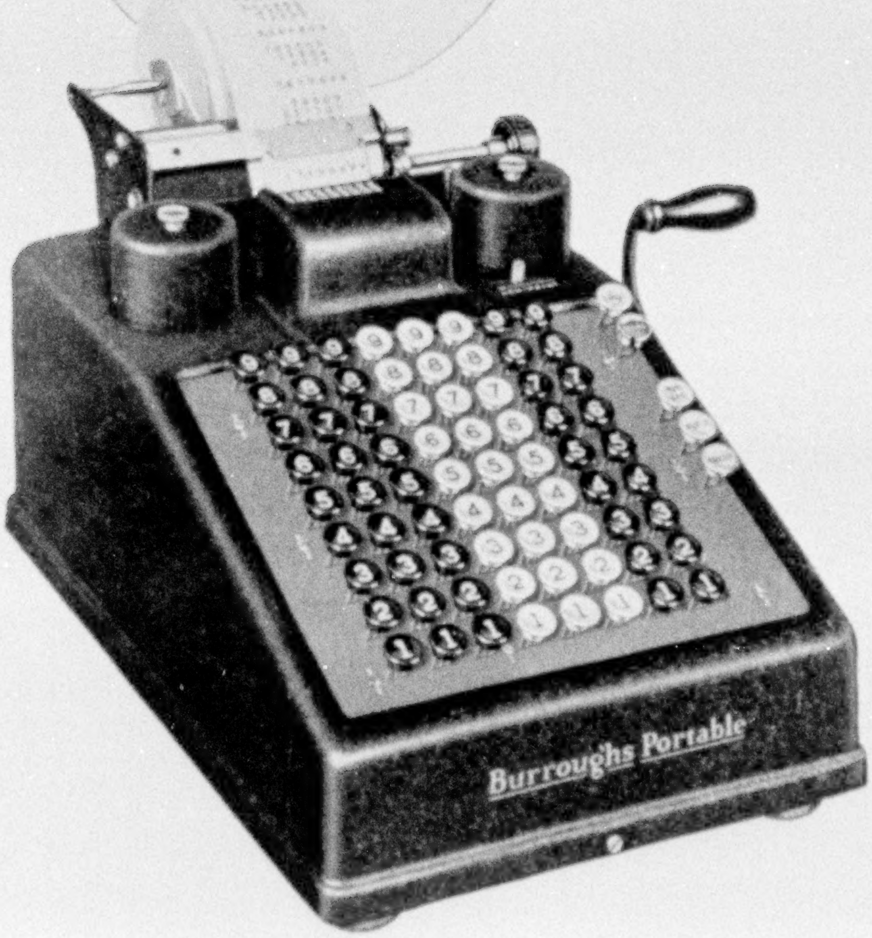

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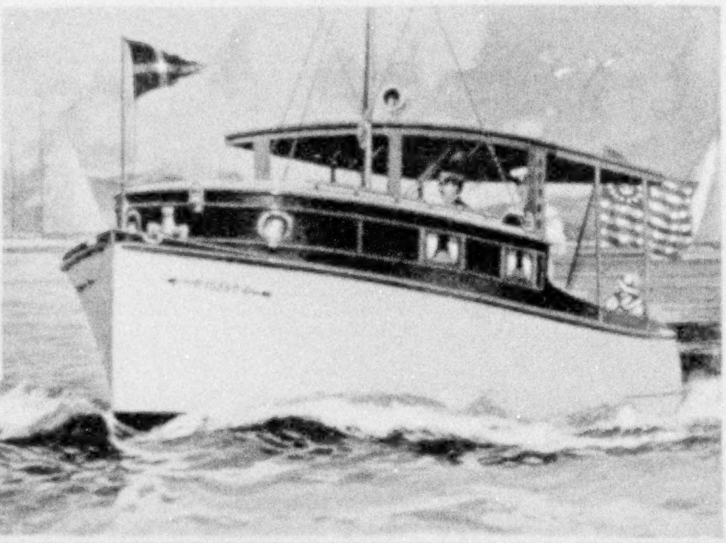

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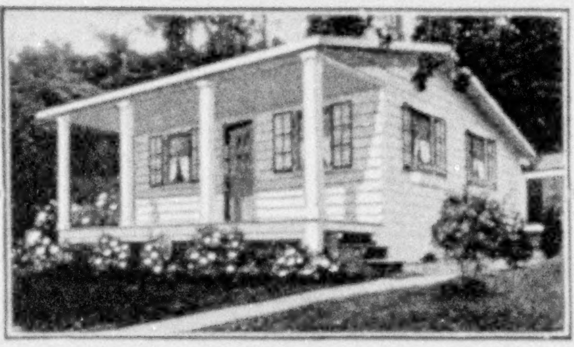

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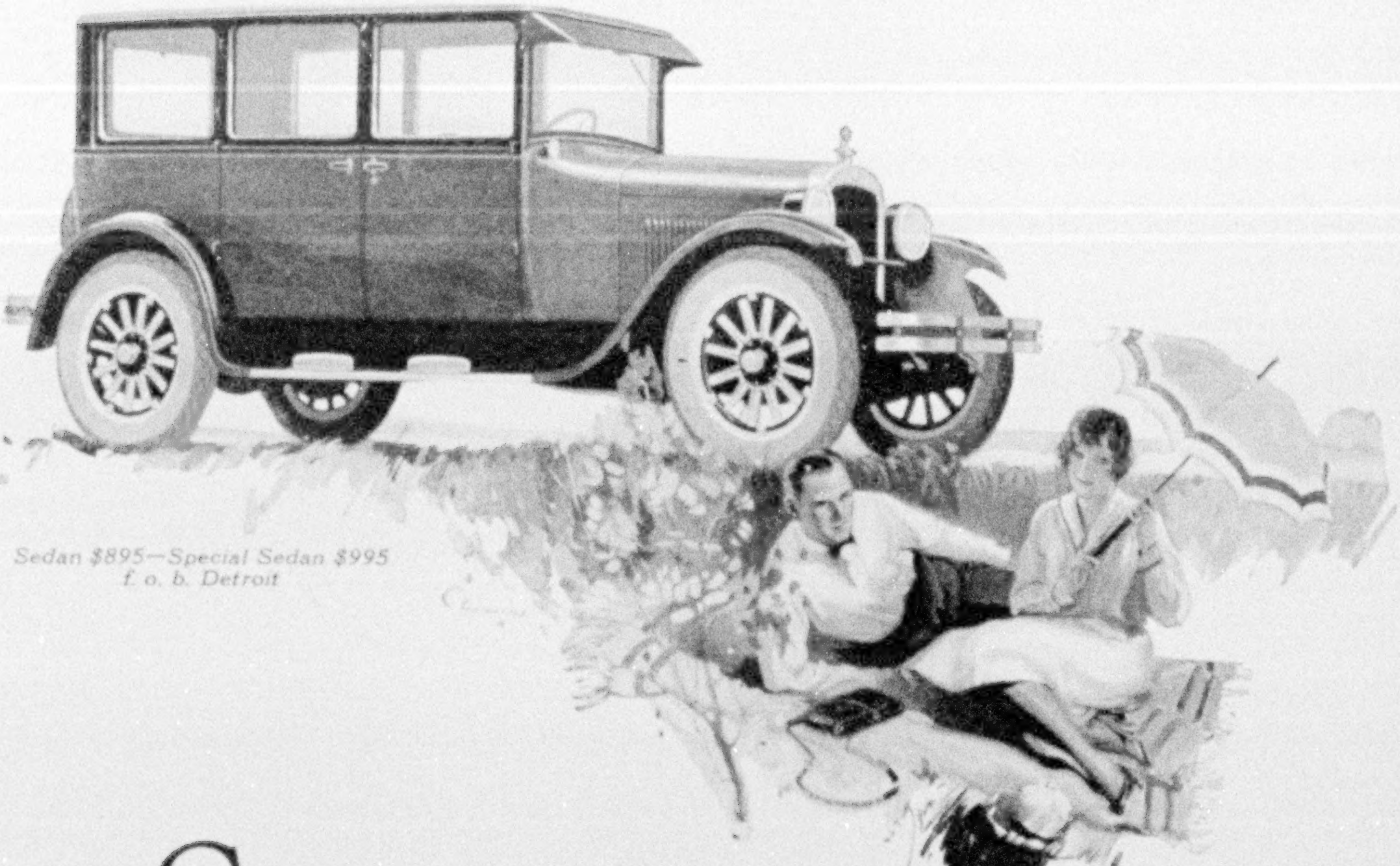

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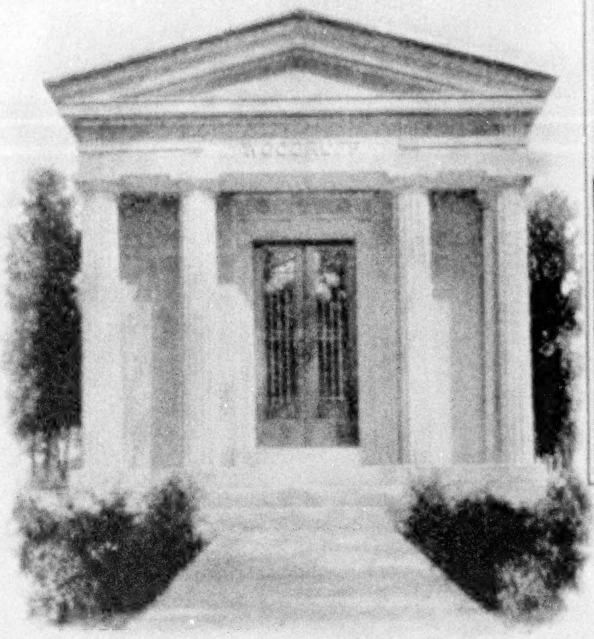

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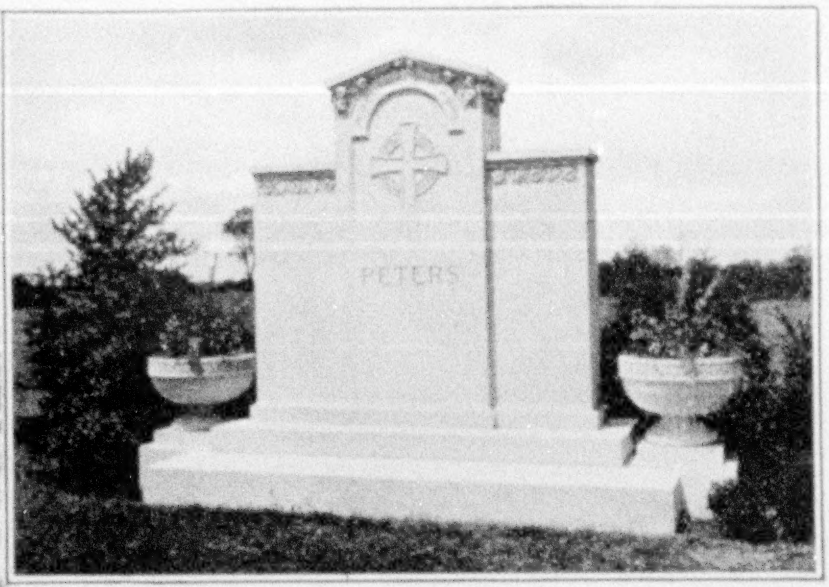

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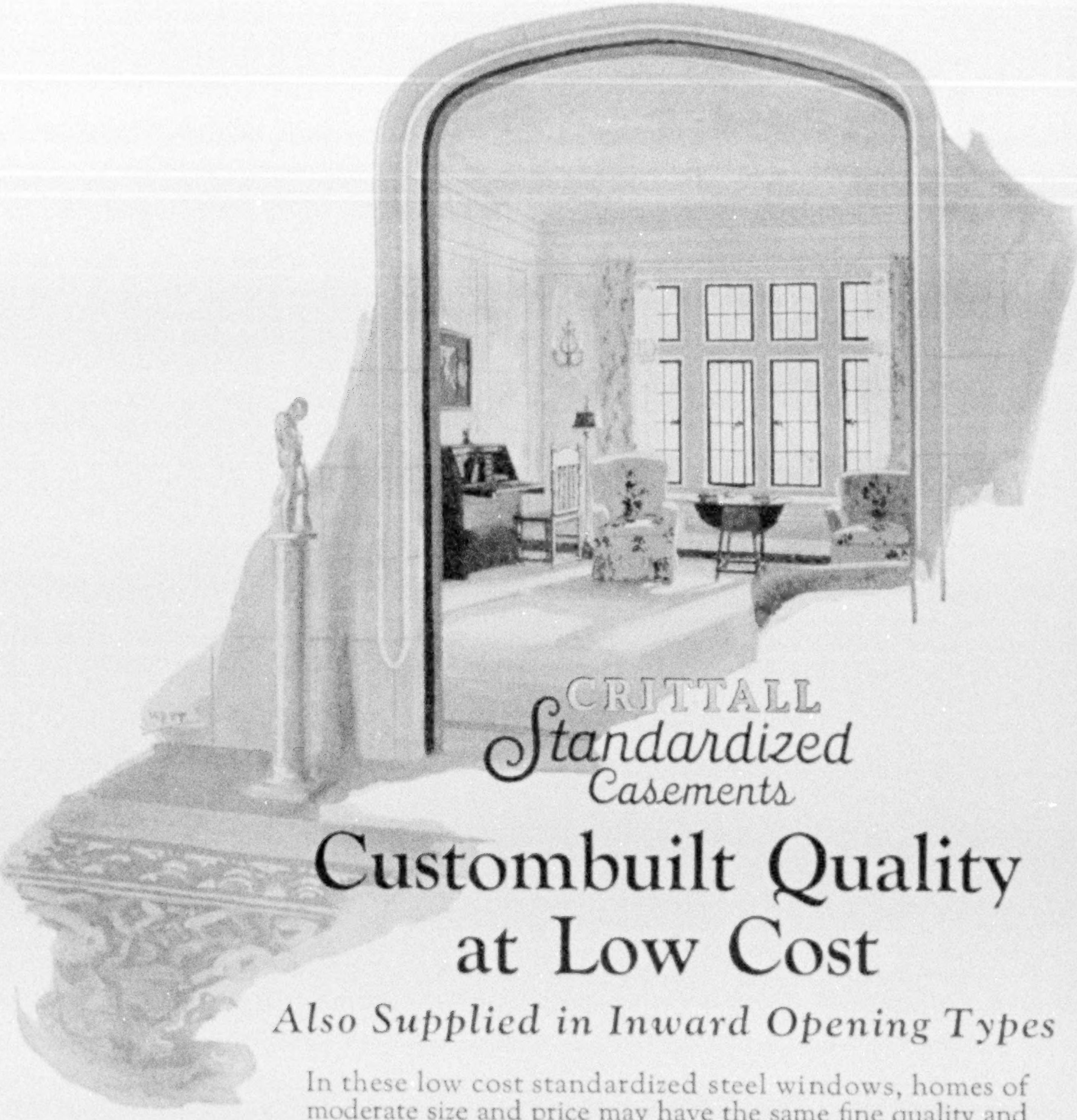

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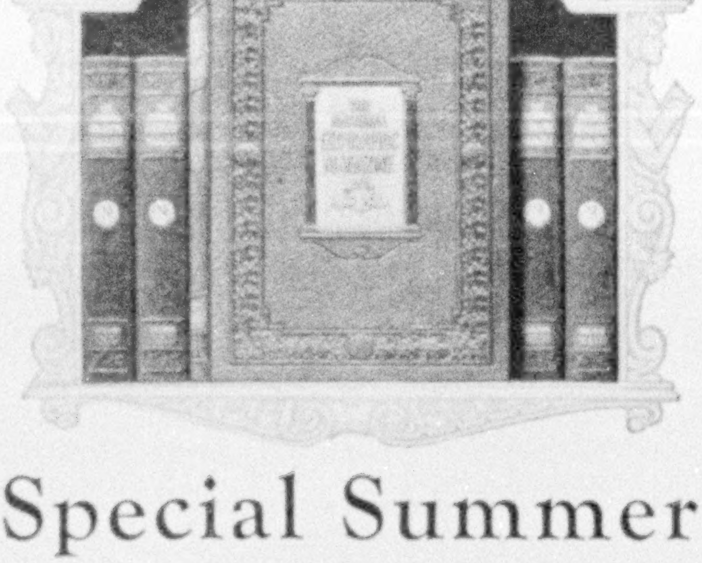

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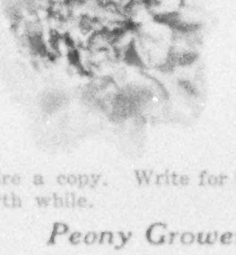

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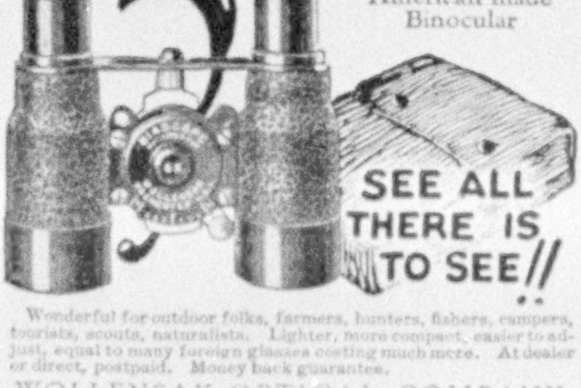
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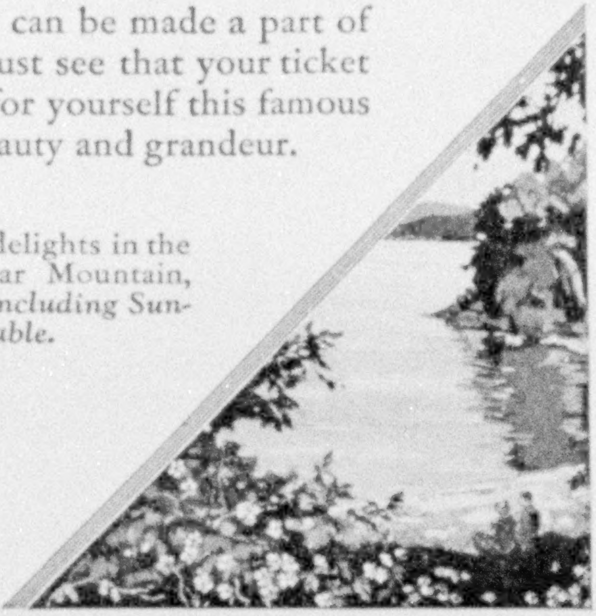

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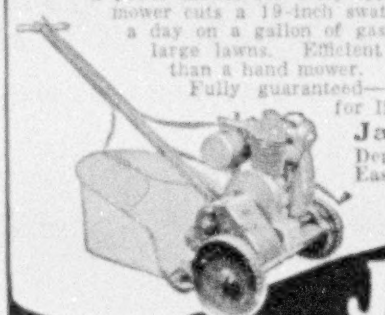

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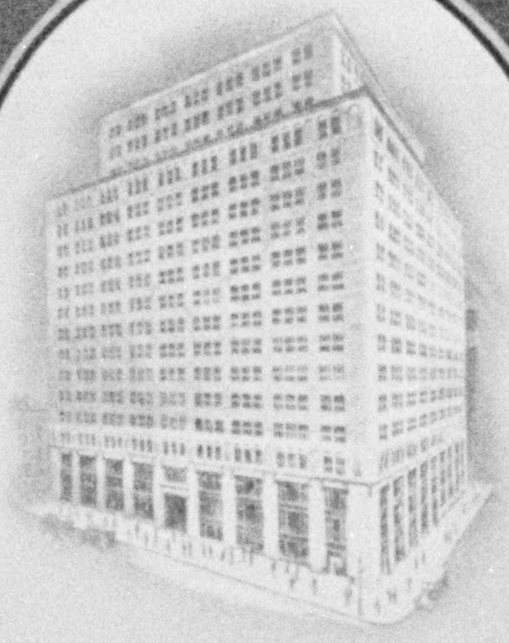

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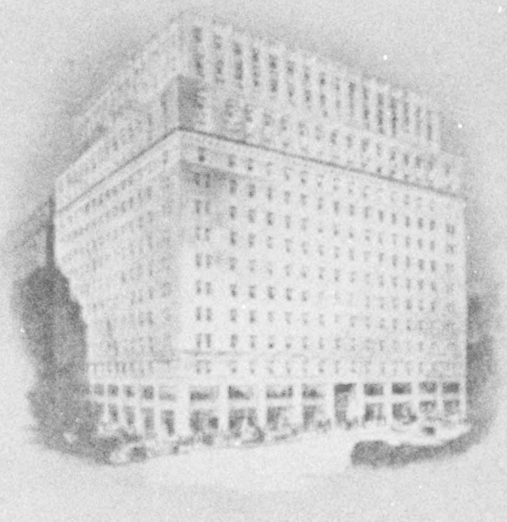

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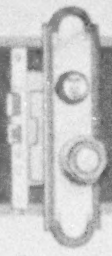

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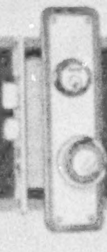

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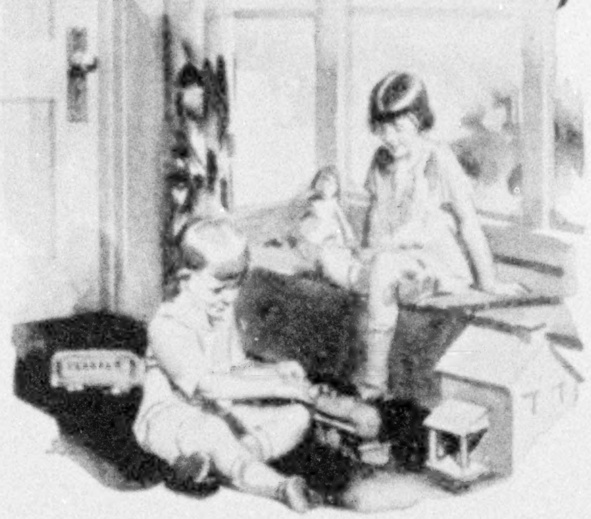

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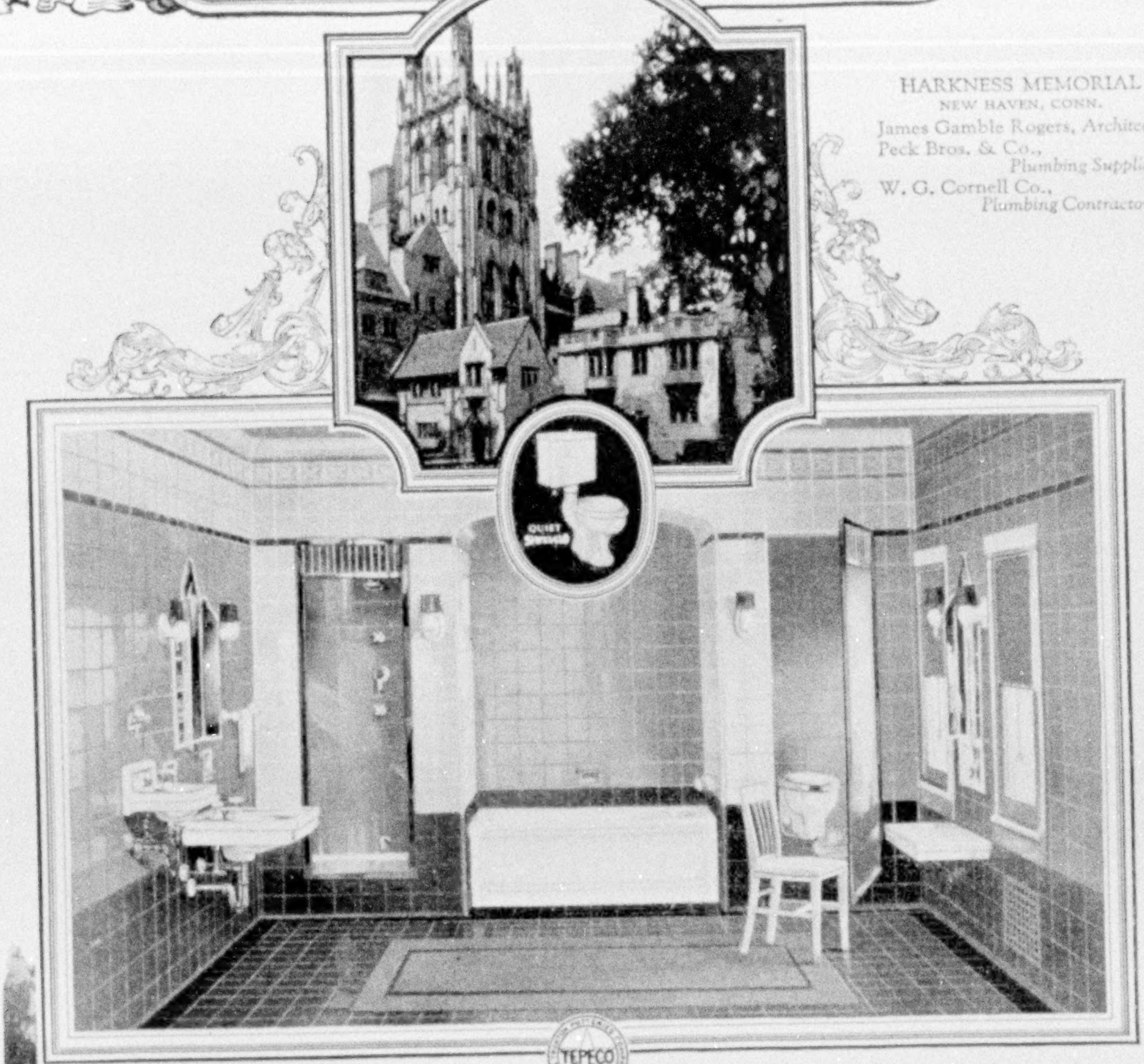

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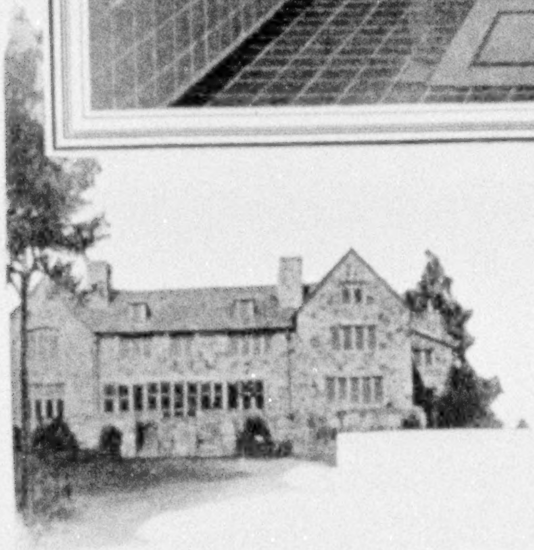

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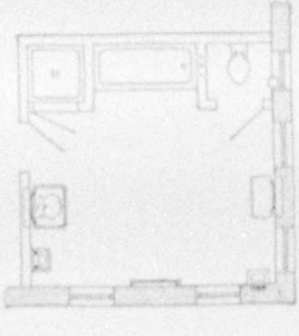

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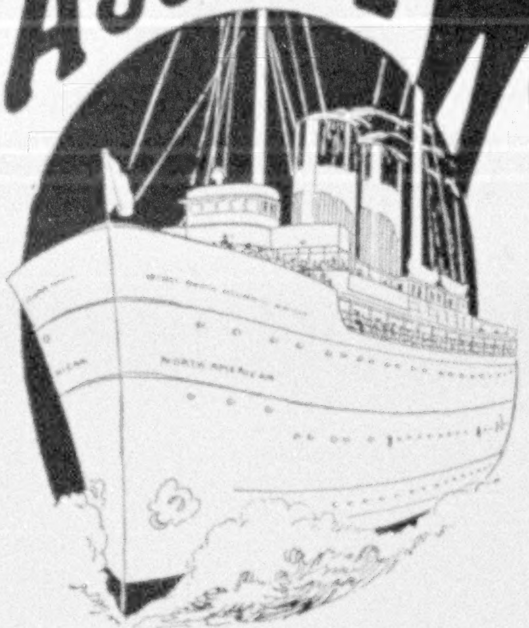

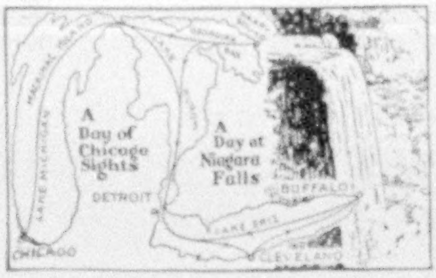

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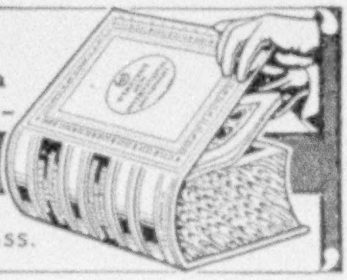

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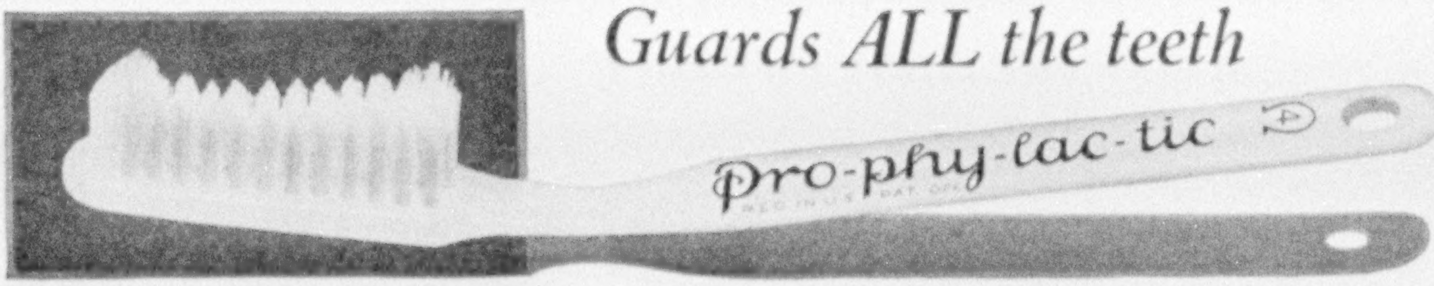

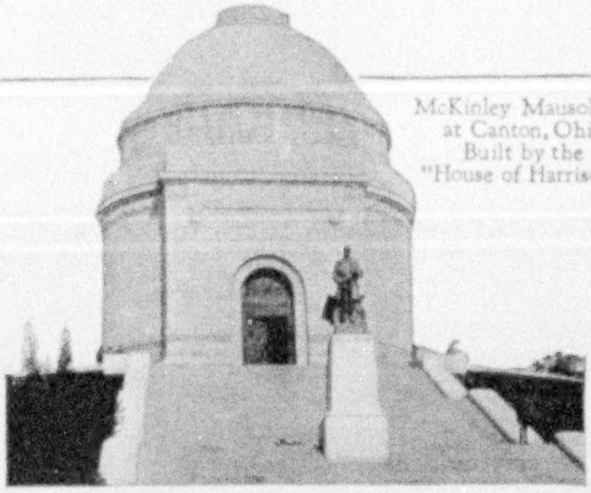

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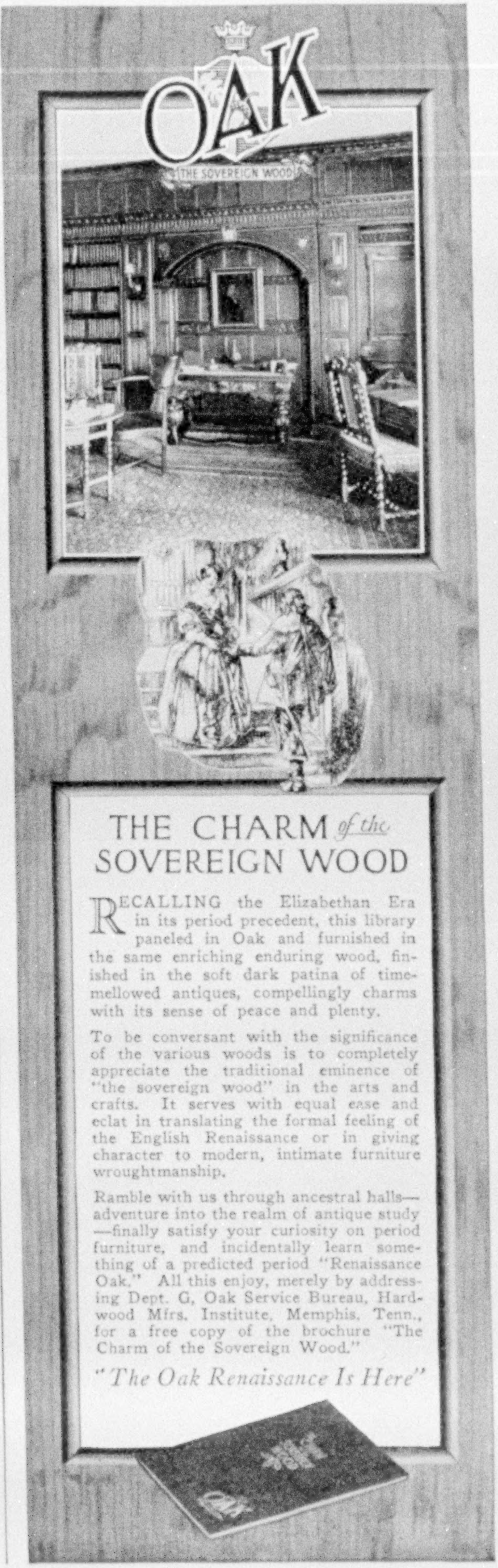

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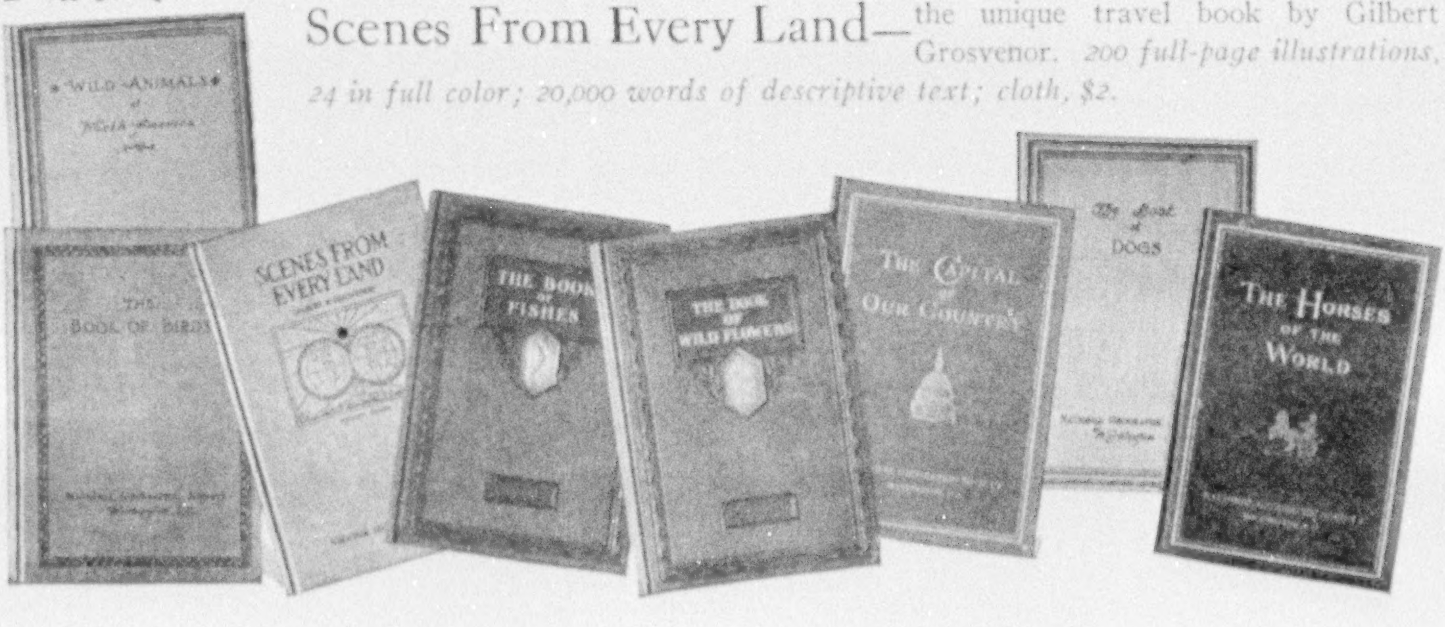
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To Hang Heavy Articles on Walls or Woodwork Use

Moore Push-less Hangers

Scientifically Constructed for Strength

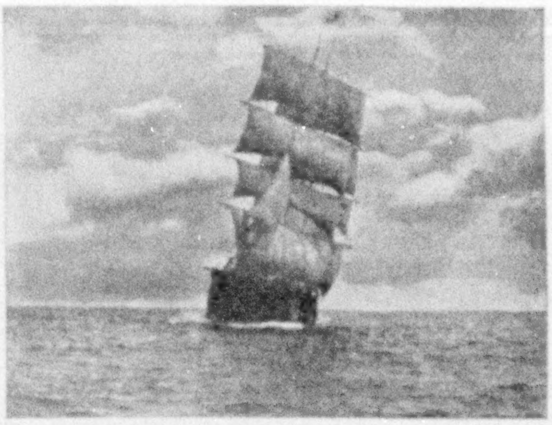
Tool-tempered steel points insure safety and will not injure plaster or woodwork.

10c Pkts. Everywhere

Moore Push-Pin Co., Philadelphia, Pa.

Manufacturers of Colored Map Tacks

For Summer Home or Camp



THE ARGOSY OF GEOGRAPHY

An old-time "Square Rigger," from a photograph by John Oliver La Gorce. Blue graphotint, 27 x 20 inches, on fine art paper, *$1.50.*

Framed, $8.00, Postpaid in U. S.

Pictures de Luxe in All Save Price

WORTHY of any home, club, or office, these pictures are ideal for beautifying summer places—because of the reasonable cost and of the unusual charm of the scenic and Nature subjects in the series.

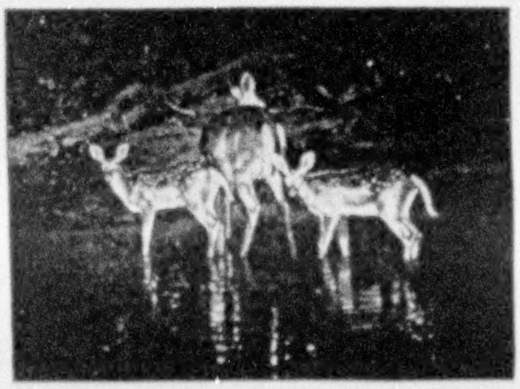
Other Outdoor Subjects:

Rumanian Peasant Girl
Prayer in the Desert
Babes in the Woods
The Torii, Japan
The Palms
Hark

50c each; framed, $5. Postpaid in U. S. Foreign mailing of unframed prints, 25c.

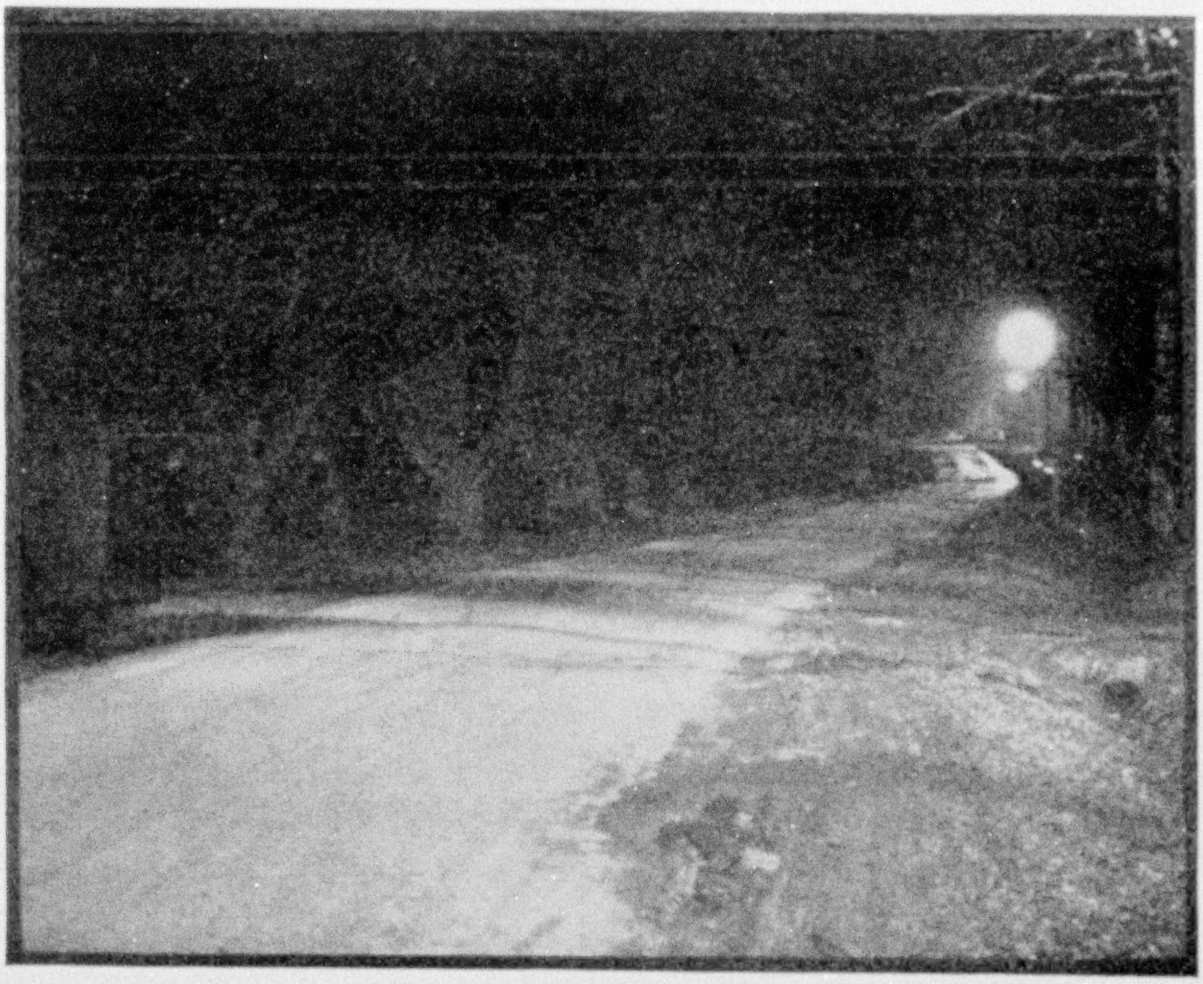
Illustrated description on request

National Geographic Society
Washington, D. C.



THE DOE AND TWIN FAWNS

Sepia, 12 x 8 inches, 50c; framed, $5



Electric lights brighten the highways
in the township of Amherst, N. Y.

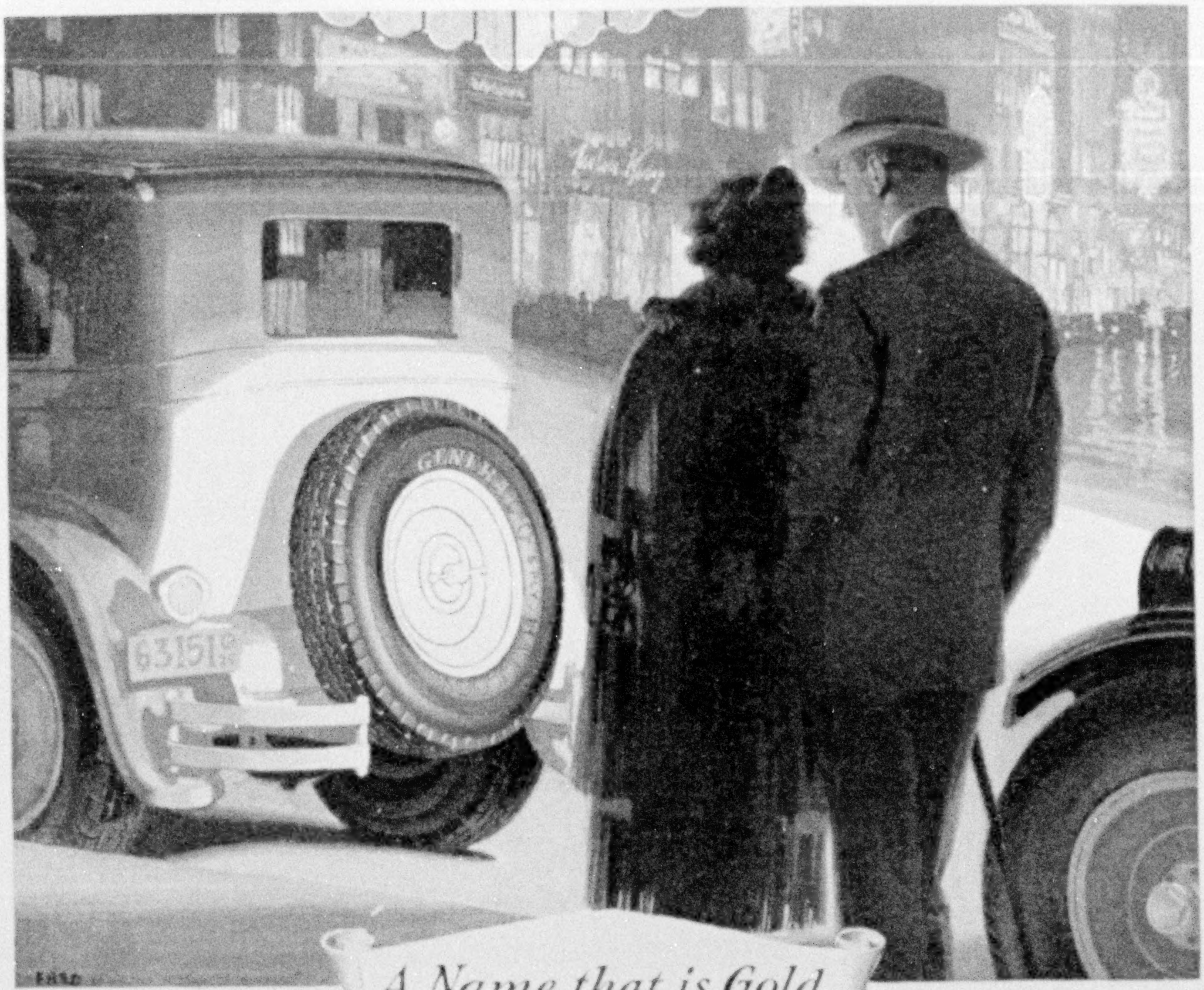
Amherst Votes "Aye"

"Shall this township light its highways?" was the question submitted to the electors in 1921. It was carried, and Mr. John M. Wehrle, Town Supervisor, asked the General Electric Company to install the lights.

"No other enterprise," writes Mr. Wehrle, "has done so much for our general welfare. It has attracted hundreds of people to Amherst. Building operations have been stimulated beyond conception."

Compared with other municipal improvements, good lighting usually costs least and does most. When your city demands better lighting, the illuminating engineers of the General Electric Company will submit plans and estimates, and show your officials in person what other cities are doing.

GENERAL ELECTRIC



A Name that is Gold in the Night

THE names of men and products are lifted above the average through distinguished service or accomplishment. Such are the names that help to brighten any Broadway—names that are gold in the night. The General Tire is one.

Now, more than ever before, the confidence in General's policy of absolute maintenance of quality is shown by the big swing to Generals everywhere . . . . a confidence that has been earned through General's policy of not tampering with quality.

This is the reason you hear users everywhere speak of General in terms of almost unbelievable mileage, comfort and safety. In a brief period of ten years the name General Tire has taken first place in car owner preference.

The General dealer has a plan that enables you to change to Generals now without sacrificing the unused mileage in your present tires, no matter what make or how much or how little they have been used.

The General Tire and Rubber Co.,
Akron, Ohio.

The Mark of Leading Tire Stores Everywhere

The GENERAL TIRE

—GOES A LONG WAY TO MAKE FRIENDS

An Immense Step Ahead
"POSITIVE AGITATION"

YES, vacuum cleaners still are made and sold. So are buggies, for that matter.

But the enlightened woman today demands something more—the *new*, the *improved*, the *advanced*—the cleaning principle that takes dirt *out* of her rugs, instead of merely *off* them.

She demands "Positive Agitation," the remarkable principle perfected in the *new* Hoover. This revolutionary cleaner surpasses even the standard-design Hoover in these important particulars:

1 For the first time, it makes possible "Positive Agitation" of floor coverings.

2 By actual test, in the ordinary cleaning time, it beats out and sweeps up from carpetings an average of 131% more dirt.

3 It is an even greater rug-saver; the oftener a carpet is cleaned with a Hoover the longer that carpet will wear.

4 It is virtually service-proof, every part, including the new motor, requiring no oiling.

5 It increases the efficiency of its remarkable dusting tools because of its 50% stronger suction.

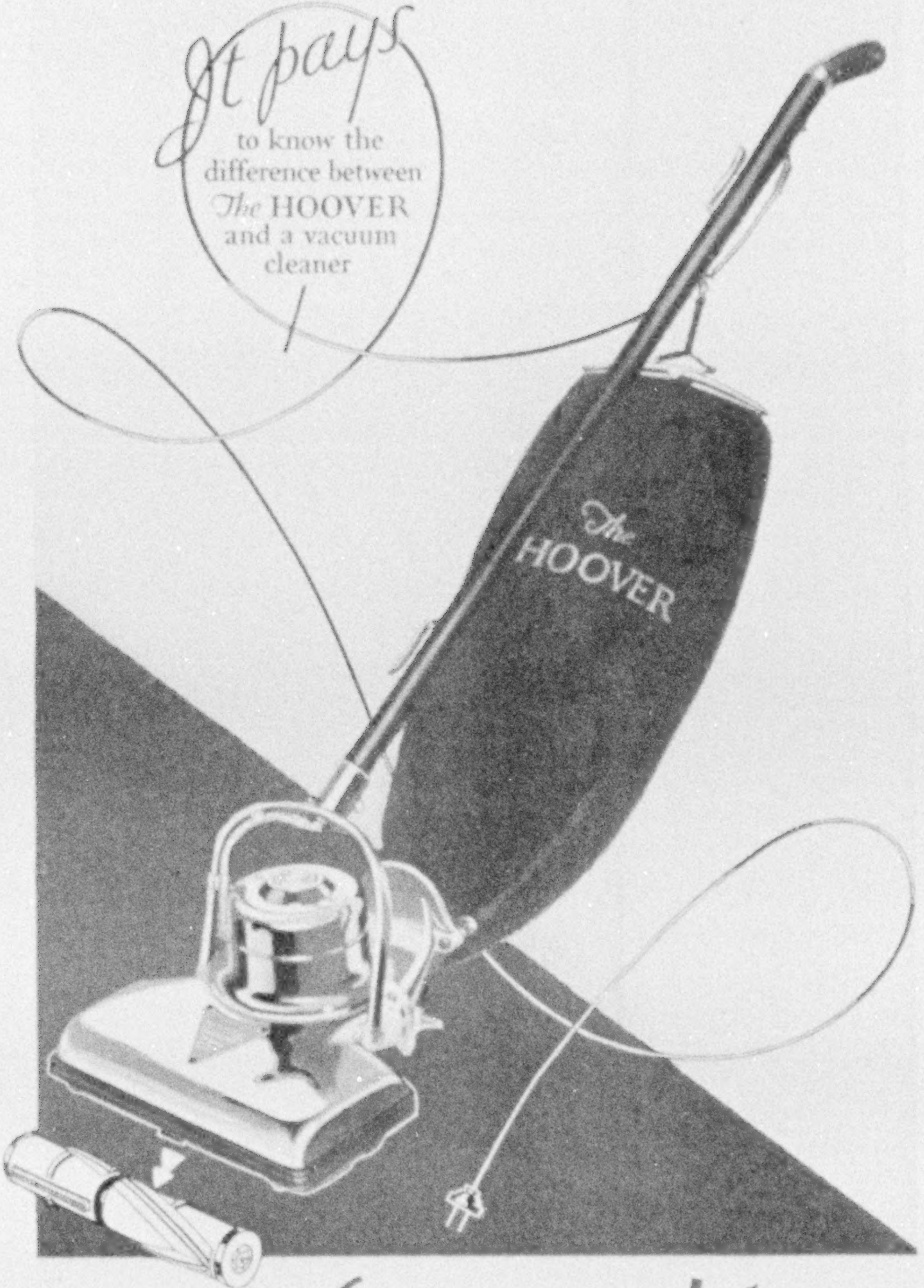
6 Its exclusive dust- and germ-proof bag is now washable.

7 Its form and finish are of startling beauty; and every new feature insures greater operating ease.

Those who have seen the new Hoover say it *antiquates* any earlier method of home cleaning and rug care. Yet any Authorized Hoover Dealer will deliver you this unrivaled cleaner for only $6.25 down, with the balance in easy monthly payments.

THE HOOVER COMPANY
NORTH CANTON, OHIO

The oldest and largest maker of electric cleaners. The Hoover is also made in Canada, at Hamilton, Ontario



The Greater
HOOVER

It BEATS ... as it Sweeps as it Cleans

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